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THE

MECHANICAL PRINCIPIA;

CONTAINING ALL THE VARIOUS

CALCULATIONS ON WATER AND STEAM POWER,

AND ON THE DIFFERENT KINDS OF

MACHINERY USED IN MANUFACTURING;

WITH TABLES SHOWING THE

COST OF MANUFACTURING DIFFERENT STYLES OF COTTON GOODS.

BY

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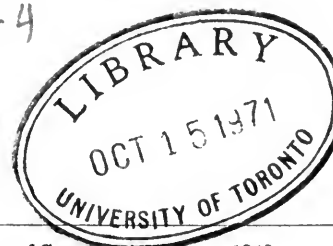

PREFACE.

THE present work pretends to no other merit than that of being a laborious collection of the most useful calculations for the mechanic and manufacturer.

All the various calculations on motive power have been condensed and arranged in as comprehensive a mode as possible, which are such as to enable the mechanic to obtain the solution of any problem, simply by referring to the tables. Hence it will be seen, that those mechanics who possess very little mathematical knowledge, will be able to obtain the solution of the most intricate problems in mechanical science. To obtain the theoretical power of a water site or a steam engine becomes, as it were, a purely mechanical problem; but unless the ratio of the theoretical and practical results are known, these solutions would be of very little practical use to the mechanic. So far as circumstances would permit, this ratio of the difference between theory and practice has been obtained, and the results carried out in the different tables. The table containing calculations on the steam engine shows the theoretical power, on account of the diversity of opinion in regard to the per cent loss of

power due to escape-steam, friction of the engine, &c. It has been left optional with the mechanic, in making his calculations, what per cent to allow. From a great number of observations, we conclude that the effective power of a high-pressure engine, when the steam does not act expansively, is about 45 per cent less than that due to the pressure indicated by the *gage* on the boiler. Hence, to find the effective power of an engine, deduct 45 per cent of the pressure indicated by the gage.

The tables showing the cost per yard of manufacturing different styles of goods from different prices of cotton, were predicated upon the yearly results of a large number of factories. There is no doubt that some of the recently erected factories, particularly those which are making printing goods, are able and do manufacture at less cost per yard, than the amounts represented in the tables. Some of those which are making printing goods containing 54 by 58, 60 by 64, and 64 by 68 threads per square inch, are able to manufacture probably for some three or four mills per yard less than represented in the tables; but these are isolated cases, and should not therefore govern or influence in any manner the statements which profess to show the usual cost of manufacturing.

The table which contains the calculated power of belts we believe is the first which has appeared of its kind. As the calculations are predicated upon practical results, we put them forward as correct data upon which all the various calculations on belting can be safely predicated. The elements from which these calculations were made are duly considered in the General Explanations of the different

tables. An experiment on the power of a belt is also given in one of the notes at the end of the work.

The table showing the per cent loss of the power of a stream, when it is transmitted by the overshot or breast wheel, we believe will not differ essentially from the true and actual result. As every element which is involved in Note A is predicated upon mathematical truths, except the per cent loss of the power due to the velocity of the wheel, this element becomes as it were a distinct mathematical theorem, which, when considered in detail, gives a result nearly corresponding with that given in Note A.

As this work was designed as a book of reference, it was concluded best not to give the mode of ascertaining the general results, but to reserve that for another work which will be considered a Key to this, which will consist of two parts, the first giving the origin of all the *rules* in mechanical science in *algebra*, and also the origin of all the rules by which all the various calculations in this work were made; the second part will give the same results, but in an arithmetical form.

All must readily admit that it required no small amount of labor to perfect the present work, and that its design proposes a plan of arranging calculations, which cannot fail to be very useful to the mechanic and manufacturer.

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EXPLANATION OF TERMS USED IN THIS WORK.

A *Horse Power* is considered in all the calculations in this work to be equal to 33,000 pounds raised one foot high per minute.

A *Hank* or *Skein* is equal to 840 yards.

Co-efficient of Discharge is that *number* which must be multiplied by the square root of the head to obtain the velocity of the water when it leaves the opening.

GENERAL EXPLANATION

OF THE DIFFERENT TABLES.

It will be observed that there is connected with each table an explanation, showing the mode of performing or taking out a calculation; there are also examples given, to show the mode in detail of taking out a calculation. At the end of the work there are a large number of Problems given, which refer to the different tables to obtain elements, which when combined, give the solution of the Problem; the design of the following observations, is to explain more fully some of the tables.

The actual quantity of water passing into a straight canal in a given time, the bottom of which being level, and the sides perpendicular, will not differ materially from that found by calculation in Table No. 1; but if these three elements are variable, the result obtained by calculation will not be so certain; hence, the different results which could have been obtained from this, and carried into those Problems given to illustrate the application of the different tables have been omitted, because it was feared that there would

not be a sufficient degree of accuracy attending them, to correspond with those results which are predicated upon mathematical truths, which are linked in the series of the different calculations. Unless the location is very favorable, the results obtained by this table can only be considered as an approximation to the true result.

Tables No. 1 and 2, show the number of cubic feet of water passing in a stream per second; Table No. 3, shows the number of horse power which this quantity of water will produce when applied to different falls; this quantity of water may be applied to the overshot, breast, Parker's, or the outward and inward discharging turbine wheels, all of which probably produce about the same effect. It must be borne in mind that this table shows the effective power; that is, the usual per cent loss of the foregoing wheels has been deducted from that which is due to the quantity of water applied to the whole fall.

Table No. 5, shows the amount of back-water; when the width of the *race*, and the quantity of the water discharged from the wheel per second are known, as the Millwright always knows the horse power of the wheel, he can easily find the number of cubic feet of water that will be discharged into the wheel pit per second: for instance, suppose the fall of a breast or the diameter of an overshot wheel to be 12 feet, and 20 horse power; in order to find the number of cubic feet of water discharged from this wheel per second, turn to Table No. 3; find 12 in the column marked "Diameter," below this number in the table find 20, or the nearest number to it, which is 19.99; now opposite to this number in the column marked "No. Feet," will

be found 22 cubic feet; hence it will be seen, that if the fall of the breast or the diameter of the overshot is known, and also the power of the wheel, the number of cubic feet of water discharged can be readily found. It will be noticed that the fall of the breast or the diameter of the overshot wheel is about 3 feet less than the whole fall; hence in case the quantity of water discharged from the turbine or Parker's wheel should be required, it would be necessary to deduct 3 feet from the whole fall: for instance, suppose the power of a turbine wheel to be 30 horse, and the whole fall to be 15 feet, deduct 3 feet, which gives 12 feet effective fall—find 12 in the column marked "Diameter," in Table No. 3; below this number in the table find 30, or the nearest number to it, which is 29.99; opposite to this number in the column marked "No. Feet," will be found 33 cubic feet discharged per second.

Table No. 8, shows the number of cubic feet of water discharged per second through gates under different heads; for instance, suppose the head to an overshot wheel to be 2 feet or 24 inches, the length of the gate being 12 feet, and it is open 3 inches; now the length of the gate, which is 12 feet or 144 inches, multiplied by 3 inches, gives 432 inches —now find 24 in the column marked "Head," opposite to this number in the column marked "No Feet," will be found 5.46, which multiplied by 4.32, gives 23.58 cubic feet discharged per second: suppose this quantity of water to be applied to an overshot wheel, 16 feet in diameter; required, the horse power; turn to Table No. 3—find 23.58, or say 24 in the column marked "No. Feet," opposite to this number in the table, and under 16 in the column marked "Di-

ameter," will be found 29.08 horse power. Again, required, the proper length of an overshot wheel to receive 24 cubic feet of water per second; in the previous statement it was found, that 24 cubic feet of water applied to an overshot wheel 16 feet in diameter per second, would produce 29.08 horse power; now turn to Table No. 9—find 16 in the column marked "Diameter," opposite to this number in the table find 29.08, or the nearest number to it, which is 28.1, over this number and in the column marked "Length," will be found 9 feet, the required length of the wheel; the coefficient of discharge in these calculations is 5.5.

Table No. 9, shows the horse power of the overshot and breast wheels, which are calculated to run 5 feet per second, the depth of the buckets being 12 inches, and the head about 2 feet; these wheels are calculated to produce about 66 per cent of the whole power of the site.

It will be noticed that the breast wheel is calculated to produce as great effect as the overshot; there is no doubt but the breast wheel, when properly constructed and well calculated, can, and does produce as great effect as the overshot. When those elements which are involved in a series of calculations are considered in detail, they not only show that the breast wheel is equal to, but more efficacious than the overshot; they show that the *head* required to obtain the relative velocity, may be some twelve to fifteen inches less on the breast than on the overshot wheel.

In order to fully illustrate this position, suppose the breast wheel to be at rest; let the top of the buckets be just in line with the openings of the gate; now, as the buckets are twelve inches deep, the water will fall twelve inches

before it arrives to the bottom of the bucket; as the wheel moves five feet per second, and the buckets do not fill so fast as the wheel moves, the distance through which the water falls after it passes through the gate will never be less than one foot; now it does not require but two feet head to impel the water eight feet per second, hence one foot head is sufficient to give the usual relative velocity of the water to breast wheels.

The water in entering the buckets of the overshot wheel changes its direction, and therefore the depth of the bucket does not much, if any, increase the velocity of the water, consequently one foot head to the breast wheel accomplishes the same end as two feet to the overshot. The diameter of the breast wheel should exceed that of an overshot about three feet on the same fall.

Table No. 12, shows the effective power of the outward and inward discharging turbine wheels; for instance, suppose the effective head or the total head when the wheel is in operation to be 16 feet, then the horse power of the outward discharging (if the area of all the openings were 100 inches) would be 21, and the horse power of the inward discharging would be 12.1. It must not be understood that the relative effect of these wheels under the same head, and discharging the same quantity of water in the same time, is as 21 to 12.1, but that the quantity of water which these wheels discharge in the same time under a given head, and having the same area of openings, is as 21 to 12.1; this difference in the quantity of discharge is due to the motion which the water receives while passing through the wheel; the outward discharging wheel receives the water at the centre, which

escapes at the periphery—but the inward discharging receives the water at the circumference, which vents at the centre; hence it will be readily seen, that the centrifugal force which the water receives while passing through these wheels, acts with, and in opposition respectively to the force of discharge due to the head.

Table No. 10, shows the per cent loss of power of a stream when it is transmitted by the overshot or breast wheel; that is, if they are calculated according to this work. This table shows that the per cent loss of power of an overshot wheel 9 feet in diameter, or a breast wheel 9 feet fall, is 52 per cent; but if the diameter or fall of the wheel is 30 feet, there will be only 23 per cent loss; hence a difference of 29 per cent in favor of the latter wheel: when the diameter or fall of the wheel is 14 feet, the loss is 38 per cent, which deducted from 100, gives 62 per cent effective power, which is probably about the effective power of Parker's and the two turbine wheels; they may exceed 62 per cent in effect, but suppose they do not, then it would appear that these wheels produce greater effect from a given quantity of water than the overshot wheel 14 feet in diameter on the same fall: an overshot wheel 14 feet in diameter requires a fall of about 17 feet, hence these wheels are more efficacious on a fall of 17 feet than the breast or overshot.

In the present instance the overshot and breast wheels are calculated to produce a maximum effect; but there are many overshot and breast wheels in operation whose velocity much exceeds five feet per second, having more than two feet head, and the depth of the bucket much exceeding 12 inches; hence the loss power in such cases, will exceed the

amount represented in Table No. 10, in proportion as those elements differ from those represented in Note A; hence the cause of these wheels frequently being more efficacious on falls of 22 to 24 feet.

The power should be taken from the overshot and breast wheels on the side to which the water is applied, then the journals of the wheel will sustain the weight of the wheel, and the weight of the water on the wheel; but if the power is taken from the opposite side to which the water is applied, then the journals of the wheel will sustain the weight of the water on the wheel, and the resistance of the power which is nearly or quite equal to the weight of the water; hence in this case the journals of the wheel sustain the weight of the wheel, and nearly twice the weight of the water, because the journals are as it were a fulcrum sustaining the weight and power.

Table No. 5, Steam Power, shows the horse power of the condensing and non-condensing engines; there are three variable elements in the problem of calculating the power of an engine; to wit, the diameter of the cylinder, the velocity of the piston, and the effective pressure of the steam upon the piston; as only two can be represented in the table, one of the three must be omitted, or considered a constant number: in this table the velocity of the piston is constant, which is calculated to move 100 feet per minute; hence if the piston move 300 feet, the power of the engine will be increased three-fold, or the number found in the table due to 100 feet must be multiplied by 3. The probable per cent loss of different engines is given, to show the mode of ascertaining the required diameter of the cylinder to drive the

different kind of machinery represented in the different problems: it is optional with the engineer in making his calculations what per cent loss to allow.

Table No. 3, Manufacturing, shows the calculated and actual power required to drive different number and kind of spindles with looms; the actual power required, was obtained by noting the number and kind of spindles in operation in several factories which were driven by overshot wheels, having about two feet head, and running about five feet per second, whose power was calculated and carefully compared with the amount of the power of the wheels used: by this means an approximation to the actual power required was obtained; the calculated power, or the power of the wheel, exceeds the actual power about 25 per cent. On account of there being so many variable elements brought into action in a series of calculations showing the power required to drive a given amount of machinery, there has an opinion arisen among mechanics, that it is quite impossible to arrive at any definite conclusions as regards the amount of power required to drive a given amount of any kind, more especially cotton machinery; now it is quite evident that the average power required to drive the machinery in two factories, each containing the same amount and kind of machinery, and turning off the same amount of work in the same time, will not differ materially; still there may be a great difference in the amount of water which two such factories situated on the same fall would require, which difference however arises from the mode of transmitting the power (which is due to the gravitation of the water) to the machinery. It is not uncommon to see overshot and breast

wheels (more particularly the breast wheel) working under a head of four or five feet, the velocity of the wheels being some seven or eight feet per second, the depth of the bucket some 16 inches, and the whole head and fall not exceeding 16 feet: in such cases theory shows, and observations and experiments confirm, that there is not 50 per cent of the power of the site transmitted to the machinery; hence the difference in the quantity of water or power used is due to the mode of transmitting it: such palpable errors as the foregoing are often overlooked, and the difference in the amount of power or quantity of water expended, has been too often attributed to the mode of arranging the shafting, and the workmanship and condition of the machinery. It is quite evident that the difference in the amount of power required to drive the shafting, arising from its mode of arrangement, when compared with the power required to drive the whole machinery, is inconsiderable; hence this element may in the ordinary calculations be omitted. In this table the No. of the yarn, the amount and kind of the machinery, and the production, have been considered. It may be proper to remark that the power required to drive the same machinery will vary in a certain ratio with the amount which it turns off; the difference in the amount which the same kind of machinery produces is not material, but the calculations are such as to correspond with the greatest production of the different kind of machinery.

The filling is calculated to be spun on the Cap or Danforth, the ring and dead spindle frames in these calculations.

The dead and ring spindle frames turn off about 25 per cent more than the mule when spinning filling; as filling is

about half of the whole production of the factory; the increased production when the filling is spun on the frame, above the amount when the filling is spun on the mule, will be about 12 per cent, hence there will be about 12 per cent more attendant machinery: now the attendant machinery for a given number of spindles, including looms, will require about two thirds of the whole power; hence the increased power due by direct proportion is about 8 per cent; it will be safe to allow 7 per cent. The power required to spin a given amount of filling on a frame will exceed the power required to spin the same on the mule about 25 per cent; since the spinning requires one third of the whole power, or $33\frac{1}{3}$ per cent, half of the spinning will require about 16 per cent; one fourth of 16 per cent is 4 per cent, hence the whole difference is about 11 per cent, which agrees with the amount allowed in the table: in the same manner the amount of power required to drive the different number and kind of spindles was found.

The Tables ranging from No. 4 to 9 show the length of the overshot and breast wheels required to drive different number and kind of spindles on different numbers of yarn—the column marked "Fall," shows the fall of the breast wheel, or the diameter of the overshot, both of which are calculated to have about 2 feet head, the depth of the bucket being about 12 inches, and the velocity of the wheel about 5 feet per second; this table shows the length of the bucket in the wheel. It will be noticed that when the diameter of the overshot or the fall of the breast wheel is 12 feet, the length will be 72 feet to drive 10,000 mule and frame spindles on No. 10 to 25 yarn; now 72 feet may be divided into

any convenient length, say 12 feet, which will give 6 wheels, or 18 feet, which will give 4 wheels.

Table No. 12, shows the attendant machinery required for different number and kind of spindles on different numbers of yarn; it will be noticed that on No. 5 to 10 yarn, the fine speeder spindles are omitted, as they are seldom if ever used on such coarse work; many manufacturers prefer the non-twisting speeder: the number of spindles can be found by dividing the number of speeder spindles found in the table by 2.5.—Example, for 1000 spindles on No. 16 yarn, 50 fine speeder spindles are required, which divided by 2.5, gives 20 non-twisting speeder spindles; if the fly frame is preferred, multiply the number of speeder spindles found in the table by 2, the result will give the number of fly frame spindles; this ratio appears to be too great, but it agrees well in practice. It will be noticed that this table is calculated for mules and frames; if the filling is spun on the ring or dead spindle frame, add about 12 per cent to the attendant machinery; if the filling and warp is spun on the Danforth frame, add 40 per cent to to the attendant machinery. The number of yarn ranges from 5 to 10, 10 to 20, &c., but the calculations were made for No. 8, No. 16, No. 24, and No. 35 yarn.

Table No. 13, Manufacturing, shows the number of revolutions of a driven shaft per minute, when it is driven by different sized pulleys; over each table will be found the number of turns per minute which the driving shaft is calculated to run; if the line shaft makes 100 turns per minute, and the driving pulley on the same is 10 inches in diameter, then if the diameter of the pulley on the shaft to be driven

by this is 10 inches it will make 100 turns, if it is 12 inches, 14, 16, 18, 20, 22, or 24, it will respectively make 83, 71, 62, 56, 50, 45, and 42 turns per minute, which will be seen by examining the table; if the pulley on the driven shaft is 10 inches in diameter, and the pulley on the driving should be 10, 12, 14, 16, 18, 20, 22, or 24 inches, the driven shaft would respectively make 100, 120, 140, 160, 180, 200, 220, and 240 turns per minute; it will be noticed that the calculations are made for the driving shaft to run from 96 to 124 turns per minute; now suppose a shaft was running 240 turns per minute, and it was driven by a pulley 24 inches in diameter, what must be the diameter of a pulley to drive the shaft say 180 turns?—find 240 in the table marked "100 Revolutions," opposite to this number in the column marked "Driving Pulleys," will be found 24 inches, which is the driving pulley; above 240 will be found 180 turns; opposite to this number, in the column marked "Driving Pulleys," will be found 18 inches, the diameter of the pulley required; again, suppose the driven pulley on this shaft, which is calculated to run 240 turns, is 10 inches, what must be the diameter of this pulley to drive the shaft 100 turns?—opposite to 240 find 100, over this number, in the column marked "Driven Pulleys," will be found 24 inches; it will be noticed that the ratio of variation in the diameter of the pulleys is 2 inches; if it is desirable not to alter the revolutions only the number due to one inch, take half the difference which 2 inches makes: for instance, suppose the driven shaft makes 100 turns per minute, what must be the diameter of the driven pulley to drive it 110 turns per minute?—it will be noticed that a 10 inch pulley drives it 100 turns,

and a 12 inch pulley drives it 120 turns per minute ; hence, it will require a pulley 11 inches in diameter.

Table No. 2, Belting, shows the required width of belts to transmit different number of horse power—the column at the top of the table shows the diameter of the smallest drum, which must always regulate the width of the belt.

There are five elements involved in the problem of calculating the power which a belt is capable of transmitting ; to wit, the angle of the belt, the diameter of the smallest drum, and the distance between their centres, the velocity and width of the belt. In ordinary calculations the angle of the belt may be neglected—as this element is inconsiderable when compared to the whole power of the belt—and also the distance between the centre of the drums, when it exceeds 15 or 20 feet: hence, the only variable elements involved in the problem are the width and velocity of the belt, and the diameter of the smallest drum ; as only two variable elements can be represented in the table, the velocity of the belt must be considered constant, which is calculated to move 1500 feet per minute ; the power of a belt increases in a certain ratio with its velocity ; hence, the calculations in this table will be applicable to all belts whose velocity exceeds 1500 feet, leaving a surplus power in the belt, corresponding with the ratio due to the increased velocity of the belt over and above 1500 feet per minute. It is found, by a great number of observations, that the proper velocity of large belts is about 2000 feet per minute.

ERRATA.

Page	19,	Example	Second,	for 20, *read*	50 cubic feet.
"	24,	"	"	" 10, "	20.
"	39,	"	"	" 4210 "	4200 pounds.
"	68,	"	First,	" 16, "	17.2 feet.
"	77,	"	"	" centre "	counter.
"	94,	"	Second	" 31, "	30 yards.
"	102,	"	"	" 112, "	104 picks.
"	168,	Problem	No. 24,	" water "	wheel.

WATER POWER.

MECHANICAL PRINCIPIA.

WATER POWER.

The following table shows the number of cubic feet of water passing in streams per second. The column marked "Velocity" shows the number of inches that a block of wood, or any floating body, thrown into the middle of a stream, passes over per second; the column marked "No. of Feet" shows the number of cubic feet of water passing in the stream per second; the column marked "Area" shows the area of the stream, which is one foot—the quantity of water passing in a stream varies as the area of the stream—hence if the area of a stream is multiplied by the number of cubic feet of water found in the table due to one foot, the result will give the number of cubic feet of water due to that area.

Example.

Required, the number of cubic feet of water passing in a stream per second—the width of the stream being 20 feet, the depth of the stream being 2 feet (which multiplied by 20 gives 40 feet as the area of the stream), and the velocity of a floating body thrown into the middle of the stream being 24 inches per second—find 24 in the column marked "Velocity;" opposite to this number, in the column marked "No. of Feet," will be found 1.63, which multiplied by 40 (the area of the stream) gives 65.2 cubic feet of water passing in the stream per second.—*Answer.*

No. 1.

Velocity.	No. of Feet.	Area.	Velocity.	No. of Feet.	Area.
8	.47	1	42	3.00	1
10	.61	1	44	3.15	1
12	.75	1	46	3.31	1
14	.89	1	48	3.46	1
16	1.04	1	50	3 62	1
18	1.18	1	52	3.76	1
20	1.33	1	54	3 93	1
22	1.48	1	56	4.08	1
24	1.63	1	58	4.24	1
26	1.78	1	60	4.39	1
28	1.93	1	62	4.55	1
30	2.08	1	64	4.70	1
32	2.24	1	66	4.86	1
34	2.38	1	68	5.02	1
36	2.54	1	70	5.17	1
38	2.69	1	72	5.33	1
40	2.84	1			

The following table shows the number of cubic feet of water passing over dams per second, the water on the dam being any depth from 1 to 60 inches, the length of the dam being 1 foot. The quantity of water passing over dams varies as the length—hence if any length is multiplied by the number of cubic feet found in the table due to 1 foot, the result will give the number of cubic feet due to that length. The depth of the water on platform dams with the ordinary inclination should be taken at the lowest point, or where the water leaves the dam. The column marked "Depth" shows the depth of the water on the dam—the column marked "Length" shows the length of the dam, which is one foot.

EXAMPLE.

Required, the number of cubic feet of water passing over a dam per second, the depth of the water on the dam being 16 inches, and the length of the dam being 40 feet—find 16 in the column marked "Depth;" opposite to this number, in the column marked "No. of Feet," will be found 5.24 cubic feet, which multiplied by 40 feet (the length of the dam)

gives 209.6 cubic feet of water passing over the dam per second.—*Answer.*

EXAMPLE.

Required, the number of cubic feet of water passing over a dam per second, the depth of the water on the dam being 3 inches, and the length of the dam being 80 feet—find 3 in the column marked "Depth;" opposite to this number, in the column marked "No. of Feet," will be found .42, which multiplied by 80 gives 33.6 cubic feet passing over the dam per second.—*Answer.*

No. 2.

Depth.	Length.	No. of Feet.	Depth.	Length.	No. of Feet.
1	1	.08	31	1	14.11
2	1	.23	32	1	14.81
3	1	.42	33	1	15.51
4	1	.66	34	1	16.23
5	1	.92	35	1	19.91
6	1	1.20	36	1	17.67
7	1	1.51	37	1	18.43
8	1	1.85	38	1	19.18
9	1	2.21	39	1	19.93
10	1	2.57	40	1	20.71
11	1	2.99	41	1	21.41
12	1	3.40	42	1	22.29
13	1	3.83	43	1	23.06
14	1	4.28	44	1	23.88
15	1	4.75	45	1	24.68
16	1	5.24	46	1	25.53
17	1	5.72	47	1	26.36
18	1	6.24	48	1	27.10
19	1	6.79	49	1	28.00
20	1	7.32	50	1	28.97
21	1	7.88	51	1	29.81
22	1	8.44	52	1	30.62
23	1	9.04	53	1	31.56
24	1	9.60	54	1	32.45
25	1	10.22	55	1	33.26
26	1	10.84	56	1	34.26
27	1	11.47	57	1	34.95
28	1	12.01	58	1	36.00
29	1	12.77	59	1	36.95
30	1	13.43	60	1	37.80

The following table shows the horse power that different number of cubic feet of water per second will produce, when applied to overshot wheels of different diameter, or to breast wheels of different falls—the column marked "No. of Feet," shows the number of cubic feet of water to be applied to the wheel per second, the column marked "Diameter," shows the diameter of the overshot wheel, or the fall of the breast wheel.

EXAMPLE.

Required, the number of horse power that 20 cubic feet of water per second would produce, if applied to an overshot wheel 12 feet in diameter—find 20 in the column marked "No. of Feet," opposite to this number in the table, and under 12 in the column marked "Diameter," will be found 18.18 horse power.—*Answer.*

EXAMPLE.

Required, the horse power that 30 cubic feet of water per second would produce, if applied to a breast wheel, the fall being 15 feet—find 30 in the column marked "No. of Feet," opposite to this number in the table, and under 15 in the column marked "Diameter," will be found 34.08 horse power.—*Answer.*

Hence, if the horse power of the wheel is known, (the overshot, breast and turbine,) and also the head or fall, the number of cubic feet of water discharged from the wheel into the pit per second can be found. Suppose the fall to be 15 feet—then find 15 in the column marked "Diameter," under this number in the table find the horse power of the wheel—opposite to this number in the column marked "No. of Feet," will be found the number of cubic feet of water discharged into the wheel pit per second.

No. 3.

No. of Ft.	DIAMETER.							
	6	7	8	9	10	11	12	13
6	2.72	3.18	3.63	4.04	4.51	4.99	5.45	5.90
7	3.18	3.71	4.24	4·72	5.27	5 83	6.36	6.88
8	3.63	4.24	4.84	5.44	6.03	6.66	7.27	7.87
9	4 08	4.77	5.45	6.12	6.79	7.49	8.18	8.85
10	4.54	5.30	6.06	6.81	7.55	8.33	9.09	9.84
11	4.99	5.83	6.66	7.49	8.30	9.16	9.99	10.82
12	5.45	6.36	7.27	8.17	9.06	9.99	10.90	11.80
13	5.90	6.89	7.87	8.85	9.81	10 82	11.81	12.79
14	6.35	7.42	8.48	9.53	10.57	11.66	12.72	13.77
15	6.81	7.95	9.09	10.21	11.32	12.49	13.63	14.76
16	7.26	8.48	9.69	10.89	12 08	13.32	14.54	15.14
17	7.72	9 01	10.30	11.57	12.83	14.16	15.45	16.72
18	8.17	9.54	10.90	12.25	13.59	14.99	16.36	17.71
19	8.62	10.07	11.51	12.93	14.34	15.82	17.27	18.69
20	9.08	10.60	12.12	13.62	15.10	16.66	18.18	19.68
21	9.53	11 13	12.72	14 30	15.85	17.49	19.08	20.66
22	9.99	11.66	13.33	14.98	16.61	18.32	19.99	21.64
23	10.44	12.19	13.93	15.66	17.36	19.15	20.90	22.63
24	10.89	12.72	14.54	16.34	18.12	19.99	21.81	23.61
25	11.35	13.25	15.15	17.02	18.87	20.82	22.72	24.60
26	11.80	13.78	15.75	17.70	19 63	21.65	23.63	25.58
27	12.26	14.31	16.36	18.38	20.38	22.49	24.54	26.56
28	12.71	14.84	16.96	19.06	21.14	23.32	25.45	27.55
29	13.16	15.37	17.57	19.74	21.89	24.15	26.36	28.53
30	13.62	15 90	18.18	20.43	22.65	24.99	27.27	29.52
31	14.07	16.43	18.78	21.11	23.40	25.82	28.17	30.50
32	14.53	16.96	19.39	21.79	24.16	26.65	29.08	31.48
33	14.98	17.49	19.99	22.47	24.91	27.48	29.99	32.47
34	15 44	18.02	20.60	23.15	25.67	28.32	30.90	33.45
35	15.90	18.55	21 21	23.83	26.42	29.15	31.81	34.44
36	16.34	19.08	21.81	24.51	27.18	29.98	32.72	35 42
37	16.79	19.61	22.42	25.19	27.93	30.82	33.63	36.40
38	17.25	20.14	23.02	25.87	28.69	31.65	34.54	37.39
39	17.70	20 67	23.63	26.55	29.44	32.48	35.45	38.37
40	18.16	21.20	24.24	27.24	30.20	33.32	36.36	39.36
41	18.61	21.73	24.84	27.92	30.95	34.15	37.26	40.34
42	19 06	22.26	25.45	28.60	31.71	34.98	38.17	41.32
43	19 52	22.79	26.05	29.28	32 46	35.81	39.08	42.31
44	19.97	23.32	26 66	29.96	33.22	36.65	39.99	43.29
45	20 43	23.85	27.27	30.64	33 97	37.48	40.90	44 28
46	20 88	24.38	27.87	31.32	34.73	38.31	41.81	45.26
47	21.33	24.91	28.48	32.00	35.48	39.15	42.72	46.24
48	21.79	25.44	29.08	32.68	36.24	39.98	43.63	47.23
49	22.24	25.97	29.69	33.36	36.99	40.81	44.54	48.21
50	22.70	26.50	30.30	34 05	37.75	41.65	45.45	49.20

No. 3.—*Continued.*

No of Ft.	DIAMETER.							
	14	15	16	17	18	19	20	21
6	6.36	6.81	7.26	7.72	8.18	8.54	9.09	9.55
7	7.42	7.97	8.47	9.01	9.54	10.08	10.61	11.14
8	8.48	9.09	9.68	10.30	10.91	11.52	12.12	12.73
9	9.54	10.22	10.90	11.59	12.27	12.96	13.64	14.32
10	10.60	11.36	12.12	12.88	13.64	14.40	15.16	15 92
11	11.66	12.49	13.33	14.16	15 00	15.84	16.67	17.51
12	12.72	13.63	14 54	15.45	16.36	17.28	18.19	19.10
13	13.78	14 76	15.75	16.74	17.73	18.72	19.70	20 69
14	14.84	15.90	16 96	18.03	19.09	20.16	21.22	22 28
15	15.90	17.04	18.18	19.32	20.46	21 60	22.74	23.88
16	16.96	18.17	19.39	20.60	21.82	23.04	24.25	25.47
17	18.02	19.31	20.60	21.89	23.18	24 48	25.77	27.06
18	19.08	20.44	21.81	23 18	24.55	25.92	27.28	28.65
19	20.14	21.58	23.02	24.47	25.91	27 36	28.80	30.24
20	21.20	22.72	24.24	25.76	27.28	28.80	30.32	31.84
21	22.26	23.85	25 45	27.04	28 64	30.24	31.83	33.43
22	23.32	24.99	26.66	28.33	30.00	31.68	33.35	35.02
23	24.38	26.12	27.87	29.62	31.37	33.12	34.86	36.61
24	25.44	27.26	29.08	30 91	32 73	34.56	36.38	38.20
25	26.50	28.40	30.30	32.20	34.10	36.00	37.90	39 80
26	27.56	29.53	31.51	33.48	35 46	37.44	39.41	41.39
27	28.62	30.67	32.72	34.77	36.82	38.88	40.93	42.98
28	29.68	31.80	33.93	36.06	38.19	40.32	42.44	44.57
29	30.74	32.94	35.14	37.35	39.55	41.76	43.96	46.16
30	31.80	34.08	36.36	38.64	40.92	43 20	45.48	47.76
31	32.86	35.21	37.57	39.92	42.28	44.64	46.99	49.35
32	33.92	36 35	38.78	41.21	43.64	46.08	48.51	50.94
33	34.98	37.48	39.99	42.50	45.01	47.52	50.02	52 53
34	36.04	38.62	41.20	43.79	46 37	48.96	51.54	54.12
35	37.10	39.76	42.42	45.08	47.74	50.40	53.06	55 72
36	38.16	40.89	43 63	46.36	49.10	51.84	54 57	57.31
37	39.22	42.03	44.84	47.65	50.46	53.28	56 09	58.90
38	40.28	43 16	46.05	48.94	51.83	54.72	57.60	60.49
39	41.34	44 30	47.26	50.23	53.19	56.16	59.12	62.08
40	42.40	45.44	48.48	51.52	54.56	57.60	60.64	63.68
41	43.46	46.57	49 69	52.80	55 92	59 04	62.15	65.27
42	44 52	47.71	50.90	54 09	57.28	60.48	63 67	66.86
43	45.58	48.84	52.11	55 38	58.65	61.92	65.18	68 45
44	46.64	49.98	53.32	56.67	60.01	63.36	66.70	70.04
45	47.70	51.12	54·54	57 96	61.38	64.80	68.22	71.64
46	48.76	52.25	55 75	59.24	62.74	66 24	69.73	73 23
47	49 82	53.39	56 96	60.53	64.10	67.68	71.25	74 82
48	50.88	54.52	58.17	61.82	65.47	69.12	72 76	76.41
49	51.94	55 66	59.38	63.11	66.83	70 56	74.28	78.00
50	53.00	56.80	60.60	64.40	68.20	72.00	75.80	79.60

No. 3.—*Continued.*

No of Ft.	DIAMETER.								
	22	23	24	25	26	27	28	29	30
6	10.00	10.46	10.92	11.37	11.83	12.28	12.74	13.20	13.65
7	11.67	12.20	12.74	13.27	13.80	14.33	14.86	15.40	15.93
8	13 34	13.95	14 56	15.16	15.77	16.38	16 99	17.60	18.20
9	15.01	15.69	16.38	17.06	17.74	18 43	19.11	19.80	20.48
10	16.68	17.44	18.20	18.96	19.72	20.48	21 24	22.00	22.76
11	18.34	19 18	20.02	20 85	21.69	22.52	23.36	24.20	25.03
12	20.01	20.92	21 84	22.75	23.66	24 57	25.48	26.40	27.31
13	21.68	22.67	23.66	24.64	25.63	26.62	27.61	28.60	29.58
14	23.35	24.41	25.48	26.54	27.60	28.67	29.73	30.80	31.86
15	25.02	26.16	27.30	28.44	29 58	30.72	31 86	33.00	34.14
16	26.68	27.90	29.12	30.33	31.55	32.76	33.98	35.20	36.41
17	28 35	29.64	30.94	32.33	33 52	34.81	36.10	37.40	38.69
18	30.02	31 39	32 76	34.12	35 49	36 86	38.23	39.60	40.96
19	31.69	33.13	34.58	36.02	37.46	38.91	40.35	41.80	43.24
20	33.36	34.88	36.40	37.92	39.44	40 96	42 48	44.00	45.52
21	35 02	36.62	38 22	39.81	41 41	43.00	44.60	46.20	47.79
22	36.69	38.36	40.04	41 71	43.38	45.05	46.72	48.40	50.07
23	38 36	40.11	41.86	43.63	45 35	47.10	48 85	50.60	52.34
24	40 03	41 85	43.68	45 50	47 32	49.15	50.97	52.80	54.62
25	41.70	43.60	45.50	47.40	49.30	51 20	53.10	55.00	56.90
26	43 36	45.34	47.32	49.29	51.27	53.24	55 22	57.20	59.17
27	45 03	47.08	49.14	51.19	53 24	55.29	57.34	59.40	61.45
28	46.70	48.83	50.96	53 08	55.21	57.34	59.47	61.60	63.72
29	48.37	50.57	52.78	54 98	57.18	59 39	61.59	63.80	66.00
30	50.04	52 32	54.60	56.88	59.16	61.44	63.72	66.00	68.28
31	51 70	54.06	56 42	58.77	61.13	63.48	65.84	68 20	70.55
32	53.37	55 80	58.24	60.67	63.10	65 53	67.96	70.40	72.83
33	55.04	57.55	60.06	62.56	65.07	67.58	70.09	72.60	75.10
34	56.71	59.29	61.88	64.46	67.04	69.63	72.21	74.80	77.38
35	58.38	61.04	63 70	66 36	69.02	71.68	74.34	77.00	79.66
36	60.04	62.78	65.52	68 25	70 99	73.72	76.46	79.20	81.93
37	61.71	64.52	67.34	70.15	72.96	75.77	78.58	81.40	84.21
38	63 38	66.27	69.16	72.04	74.93	77.82	80.71	83.60	86.48
39	65.05	68.01	70.98	73.94	76 90	79.87	82.83	85.80	88.76
40	66.72	69.76	72.80	75.84	78 88	81.92	84.96	88.00	91.04
41	68.38	71.50	74.62	77 73	80.85	83.96	87.08	90.20	93.31
42	70.05	73.24	76.44	79.63	82.82	86.01	89.20	92.40	95.59
43	71.72	74.99	78.26	81 52	84.79	88.06	91.33	94 60	97.86
34	73.39	76 73	80.08	83.42	86.76	90.10	93 45	96.80	100.14
45	75.06	78.48	81 90	85.32	88.74	92.16	95.59	99.00	102.42
46	76.72	80 22	83.70	87.21	90.71	94.21	97.70	101.20	104.69
47	78.39	81.96	85.56	89.11	92.68	96.25	99.82	103.40	106.97
48	80.06	83.71	87.34	91.00	94.65	98.30	101.95	105.60	109.24
49	81.73	85.45	89.18	92.90	96.62	100.35	104.07	107.80	111.52
50	83.40	87.20	91.00	94.80	98.60	102.40	106.20	110.00	113.80

The following table shows the required area of the canal which conveys the water from the reservoir to the flume at the wheel—the column marked "Area," shows the area of the canal in feet, the column marked "Length," shows the length of the overshot or breast wheels. It matters not what may be the diameter of the overshot or the fall of the breast wheel.

EXAMPLE.

The length of two wheels being 20 feet, and the depth of the canal being 4 feet, required, the width—find 20 in the column marked "Length," opposite to this number in the column marked "Area," will be found 34, which divided by 4, gives $8\frac{1}{2}$ feet, which is the width of the canal, because $8\frac{1}{2}$ multiplied by 4 gives 34.—*Answer.*

EXAMPLE.

The length of a wheel being 14 feet, required the area of the canal—find 14 in the column marked "Length," opposite to this number in the column marked "Area," will be found 24 feet area.—*Answer.*

There are wheels 14 feet in length, which are supplied

No. 4.

Area.	Length.	Area.	Length.	Area.	Length.
8	5	29	17	51	38
10	6	31	18	53	40
12	7	32	19	55	42
13	8	34	20	57	44
15	9	36	22	59	46
17	10	38	24	60	48
19	11	39	26	62	50
20	12	41	28	64	52
22	13	43	30	66	54
24	14	45	32	68	56
25	15	47	34	70	58
27	16	49	36	71	60

with water by pipes whose area does not exceed 14 feet, but in such cases, it requires from 4 to 6 inches head to impel the water through the pipes—hence, there are from 4 to 6 inches of the whole head lost. If circumstances will permit, the area of the canal should not be less than represented in the table.

The following table shows the depth of water in inches, in wheel pits—or it shows the difference of the depth of the water when the wheel is at rest and in motion—the column marked "No. of Feet," shows the number of cubic feet discharged from the wheel into the pit per second, the column marked "Width," shows the width of the race or water course from the wheel pit, the bottom of which (in width) is supposed to be level.

EXAMPLE.

Required, the depth of the water in a wheel pit, the number of cubic feet of water discharged from the wheel per second being 20, and the race being 12 feet wide—find 20 in the column marked "No. of Feet," opposite to this number in the table, and under 12 in the column marked "Width," will be found 7 inches, the difference in the depth of the water when the wheel is at rest and in motion.—*Answer.*

EXAMPLE.

Required, the depth of the water in a wheel pit, the number of cubic feet of water discharged from the wheel per second being 20, and the race being 10 feet in width—find 50 in the column marked "No. of feet," opposite to this number in the table, and under 10 in the column marked "Width," will be found 16 inches, the difference in the depth of the water when the wheel is at rest and in motion. —*Answer.*

No. 5.

No. of ft.	WIDTH.																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6	7	6	5	5	4	4	4	4	3	3	3	3	3	2	2	2	2
7	8	7	6	6	5	5	4	4	4	3	3	3	3	3	3	3	3
8	9	8	7	6	6	5	5	4	4	4	4	3	3	3	3	3	3
9	9	8	7	6	6	5	5	5	5	4	4	4	4	3	3	3	3
10	10	9	8	7	6	6	6	5	5	4	4	4	4	4	4	3	3
11	11	9	8	7	7	6	6	5	5	5	4	4	4	4	4	4	4
12	12	10	9	8	7	6	6	6	6	5	5	5	5	4	4	4	4
13	12	10	9	8	7	7	6	6	6	5	5	5	5	5	4	4	4
14	13	11	9	8	8	7	7	6	6	6	5	5	5	5	5	4	4
15	13	11	10	9	8	8	7	7	6	6	6	5	5	5	5	5	4
16	14	12	10	9	9	8	7	7	6	6	6	5	5	5	5	5	5
17	14	12	11	10	9	8	8	7	7	6	6	6	5	5	5	5	5
18	15	13	11	10	9	9	8	7	7	7	6	6	6	5	5	5	5
19	15	13	12	11	10	9	8	8	7	7	6	6	6	6	5	5	5
20	16	14	12	11	10	9	9	8	7	7	7	6	6	6	6	5	5
21	16	14	12	11	10	9	9	8	8	7	7	7	6	6	6	6	5
22	17	15	13	11	10	10	9	9	8	8	7	7	6	6	6	6	6
23	17	15	13	12	11	10	9	9	8	8	7	7	7	6	6	6	6
24	18	15	14	12	11	10	10	9	8	8	8	7	7	7	6	6	6
25	18	16	14	12	11	11	10	9	9	8	8	7	7	7	7	6	6
26	19	16	14	13	12	11	10	9	9	9	8	8	7	7	7	7	6
27	19	17	15	13	12	11	10	10	9	9	8	8	8	7	7	7	7
28	20	17	15	14	12	12	11	10	9	9	9	8	8	7	7	7	7
29	20	17	15	14	13	12	11	10	10	9	9	8	8	8	7	7	7
30	21	18	16	14	13	12	11	10	10	9	9	8	8	8	8	7	7
31	21	18	16	14	13	12	11	11	10	10	9	8	8	8	8	7	7
32	21	18	16	15	14	12	12	11	10	10	9	9	8	8	8	7	7
33	22	19	17	15	14	13	12	11	11	10	9	9	9	8	8	8	8
34	22	19	17	15	14	13	12	11	11	10	10	9	9	9	8	8	8
35	23	20	17	16	14	13	12	12	11	10	10	9	9	9	8	8	8
36	23	20	18	16	15	13	13	12	11	11	10	10	9	9	8	8	8
37	23	20	18	16	15	14	13	12	11	11	10	10	9	9	9	8	8
38	24	21	18	16	15	14	13	12	12	11	10	10	10	9	9	8	8
39	24	21	19	17	15	14	13	12	12	11	10	10	10	9	9	9	8
40	25	21	19	17	16	14	14	13	12	11	10	10	10	10	9	9	8
41	25	22	19	17	16	15	14	13	12	12	11	11	10	10	9	9	9
42	26	22	20	18	16	15	14	13	12	12	11	11	10	10	9	9	9
43	26	22	20	18	16	15	14	13	13	12	11	11	11	10	9	9	9
44	27	23	20	18	17	15	15	14	13	12	11	11	11	10	10	9	9
45	27	23	20	18	17	16	15	14	13	12	11	11	11	10	10	10	9
46	27	23	21	19	17	16	15	14	13	12	11	11	11	11	10	10	10
47	28	24	21	19	17	16	15	14	13	13	12	11	11	11	10	10	10
48	28	24	21	19	18	16	15	15	14	13	12	12	11	11	10	10	10
49	28	24	22	19	18	16	15	15	14	13	12	12	11	11	11	10	10
50	29	25	22	20	18	17	16	15	14	13	12	12	12	11	11	10	10

The following table shows the number of revolutions that overshot and breast wheels make per minute, of different diameters, when running 5 feet per second—the column marked "Diameter," shows the diameter of the wheels in feet, the column marked "Revolutions," shows the number of revolutions that the wheels make per minute.

EXAMPLE.

Required, the number of revolutions that a breast wheel makes per minute, the diameter being 20 feet—find 20 in the column marked "Diameter," opposite to this number in the column marked "Revolutions," will be found 4.77 revolutions per minute.—*Answer.*

EXAMPLE.

Required, the number of revolutions per minute that an overshot wheel makes, the diameter being 12 feet—find 12 in the column marked "Diameter," opposite to this number in the column marked "Revolutions," will be found 7.98 revolutions per minute.—*Answer.*

No. 6.

Diameter.	Revolutions.	Diameter.	Revolutions.	Diameter.	Revolutions.
9	10.61	17	5.61	24	3.98
10	9.55	18	5.30	25	3.84
11	8.65	19	5.03	26	3.67
12	7.98	20	4.77	27	3.53
13	7.34	21	4.54	28	3.41
14	6.82	22	4.34	29	3.29
15	6.36	23	4.15	30	3.18
16	5.96				

The following table shows the number of revolutions per minute, that the pinion which geers into the water wheel

makes of different diameters—since the circumference of the water wheels run five feet per second, and the pinion geering into the segments on the circumference of the same wheel, the diameter of the wheel will not alter or change the number of turns of the pinion per minute, if it is increased or diminished —the column marked "Diameter," shows the diameter of the pinion in feet, the column marked "Revolutions," shows the number of revolutions of the pinion and pinion shaft per minute.

EXAMPLE.

Required, the diameter of a pinion, to go on the pinion shaft, that will drive the shaft 47 turns per minute—find 47 in thecolumn marked "Revolutions;" opposite to this number in the column marked "Diameter," will be found 2 feet, the diameter of the pinion.—*Answer.*

EXAMPLE.

A shaft is making 31 turns per minute, the diameter of the pinion being 3 feet; what must be the diameter of the pinion to drive the shaft 63 turns per minute?—find 63 in the column marked "Revolutions," opposite to this number in the column marked "Diameter," will be found $1\frac{1}{2}$ feet diameter.—*Answer.*

No. 7.

Diameter.	Revolutions.
1	$95\frac{1}{2}$
$1\frac{1}{2}$	$63\frac{3}{4}$
2	$47\frac{3}{4}$
$2\frac{1}{2}$	$38\frac{3}{4}$
3	$31\frac{3}{4}$
$3\frac{1}{2}$	$27\frac{1}{4}$
4	$23\frac{3}{4}$

The following table shows the number of cubic feet of water discharged per second, under the different heads—the column marked "Head," shows the number of inches head, that is, the perpendicular distance from the level of the water to the centre of the opening—the column marked "Area," shows the number of inches area of the opening, which is 100 inches; the quantity of water discharged per second, when the head remains constant, varies as the area of the opening—hence, if any area is divided by 100, and multiplied by the number of cubic feet due to any given head represented in the table, the result will give the number of cubic feet due to that area.

EXAMPLE.

The head being 24 inches, and the area of all the openings being 360 inches, required, the number of cubic feet of water discharged per second—find 24 in the column marked "Head," opposite to this column marked "No. of Feet," will be found 5.46 cubic feet, which is due to 100 inches area; which multiplied by $\frac{360}{100}$, or 3.60, gives 19.65 cubic feet.—*Answer.*

EXAMPLE.

The head being 27 inches, and the area of all the openings being 400 inches, required, the number of cubic feet of water discharged per second—find 27 in the column marked

No. 8.

Head.	Area.	No. of Ft.	Head.	Area.	No. of Ft.
12	100	3.82	33	100	6.34
15	„	4.28	36	„	6.61
18	„	4.69	39	„	6.87
21	„	5.04	42	„	7.14
24	„	5.46	45	„	7.41
27	„	5.73	48	„	7.64
30	„	6.03			

"Head," opposite to this number in the column marked "No. of Feet," will be found 5.73, which multiplied by 4.00, gives 22.92 cubic feet.—*Answer.*

The following table shows the horse power of overshot and breast wheels—the column marked "Diameter," shows the diameter of the overshot, or the fall of the breast wheel, the column marked "Length," shows the length of the wheel; the fall on the breast wheel must always be reckoned from the upper gate—when the head exceeds two feet, add one third of the excess to the fall—suppose the head to be 4 feet, the excess is 2 feet, one third of which is 8 inches; as there are no fractions of feet in the table, call this 1 foot, when the excess exceeds 6 inches, call it 1 foot, when it is less than 6 inches, it may be omitted. The head from the upper gate should never exceed 2 feet, but it may or should be as much less as circumstances will permit. (See Note A.)

EXAMPLE.

Required, the horse power of an overshot wheel, the diameter being 22 feet, and the length being 10 feet—find 22 in the column marked "Diameter," opposite to this number in the table, and under 10 in the column marked "Length," will be found 42.9 horse power.—*Answer.*

EXAMPLE.

Required, the horse power of a breast wheel, the fall being 28 feet, and the length being 20 feet—find 28 in the column marked "Diameter," opposite to this number in the table, and under 10 in the column marked "Length," will be found 109.2 horse power.—*Answer.*

No. 9.

Diameter.	LENGTH.																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
10	7.8	9.7	11.7	13.6	15.6	17.5	19.5	21.4	23.4	25.3	27.3	29.2	31.5	33.2	35.1	37.1	39.1
11	8.5	10.6	12.8	15.1	17.1	19.3	21.4	23.6	25.7	27.9	30.1	32.2	34.3	36.5	38.6	40.8	42.9
12	9.3	11.6	14.1	16.4	18.7	21.1	23.4	25.8	28.1	30.4	32.7	35.1	37.4	39 8	42.1	44.5	46.8
13	10·1	12.5	15.2	17.7	20.3	22.8	25.3	27.9	30.4	33.1	35.4	38.1	40.5	43.1	45.6	48.2	50.7
14	10.9	13.5	16.3	19.1	21.8	24.6	27.3	30.1	32.7	35.5	38.2	41.1	43.6	46.4	49.1	51.9	54.6
15	11.7	14.5	17.5	20.5	23.4	26.4	29 2	32.2	35.1	38.1	40.9	43.9	46.8	49.7	52.6	55.6	58.5
16	12.4	15.4	18.7	21.8	24.9	28.1	31.2	34.4	37.4	40.6	43.6	46.8	49.9	53.1	56.1	59.3	62.4
17	13.2	16.4	19.8	23.2	26.5	29.9	33.1	36.5	39.7	43.1	46.4	49.8	53.1	56.4	59.6	63.1	66.3
18	14.1	17.4	21.1	24 6	28.1	31.6	35.1	38.7	42.1	45.7	49.1	52.7	56.1	59.7	63.1	66.7	70.2
19	14.8	18.4	22.2	25.9	29.6	33.4	37.1	40.8	44.4	48.2	51.8	55.6	59.2	63.1	66.6	70.4	74.1
20	15.6	19.4	23.4	27.3	31.2	35.2	39.1	43.1	46.8	50.8	54.6	58.6	62.4	66.4	70 2	74.2	78.1
21	16.4	20.3	24.5	28.7	32.8	36.9	40.9	45.1	49.1	53.3	57.3	61.5	65.5	69.7	73.7	77.9	81.9
22	17.1	21.3	25.7	30.1	34.3	38.7	42.9	47.3	51.4	55.8	60.1	64.4	68.6	73.1	77.2	81.6	85.8
23	17.9	22 2	26.9	31.4	35.9	40.4	44.8	49.4	53.8	58.4	62.7	67.3	71.7	76.3	80.7	85.3	89.7
24	18.7	23.2	28.1	32.8	37.4	42.2	46.8	51.6	56.1	60.9	65.5	70.3	74.8	79.6	84.2	89.1	93.6
25	19.5	24.2	29.2	34 1	39.1	44.1	48.7	53.7	58.5	63.5	68 2	73.2	78.1	83.1	87.7	92.7	97.5
26	20.3	25.2	30.4	35.5	40.6	45.7	50.7	55.9	60.8	66.1	70.9	76.1	81.1	86.3	91.2	96.4	101.4
27	21.1	26.1	31.5	36.9	42.1	47.5	52.6	58.1	63.1	68.5	73.7	79.1	84.2	89.6	94.7	100.1	105.3
28	21.8	27.1	32.7	38.2	43.7	49.2	54.6	60.2	65.5	71.1	76.4	82.0	87.3	92.9	98.2	103.8	109.2
29	22.6	28.1	33 9	39.6	45.2	51.1	56.5	62 3	67.8	73.6	79.1	84.9	90.4	96.2	101.7	107.5	113.1
30	23.4	29.1	35.1	41.1	46.8	52.8	58.5	64.5	70.2	76.2	81.9	87.9	93.6	99.6	105.3	111.3	117.1

The following table shows the per cent loss of the power of a stream, when it is transmitted by the overshot or breast water wheel, according to the statement in note A, the general truth of which is so apparent it was thought prudent to calculate the following table from it; there may be a small error in the statement, showing the per cent loss of power due to the relative velocity of the wheel, and that which is due to the head, which, when corrected, would probably increase the per cent loss of the power. All the calculations on the overshot and breast water wheels in this work, are calculated from the old statements and rules.—The column marked "Fall," shows the fall of the breast wheel, or, the diameter of the overshot wheel; the column marked "Per Cent," shows the per cent loss of the power on different falls.

EXAMPLE.

The fall of a breast wheel being 18 feet, required, the per cent loss, (the head being 2 feet,)—find 18 in the column marked "Fall," opposite to this number in the column marked "Per Cent," will be found 33 per cent loss.—*Answer.*

EXAMPLE.

The diameter of an overshot wheel being 9 feet, required, the per cent loss—find 9 in the column marked "Fall," opposite to this number in the column marked "Per Cent," will be found 52 per cent loss.—*Answer.*

No. 10.

Fall.	Pr. Cent	Fall.	Pr. Cent	Fall.	Pr. Cent
9	52	17	34	24	26
10	49	18	33	25	25
11	45	19	31	26	25
12	43	20	30	27	24
13	41	21	29	28	24
14	38	22	28	29	23
15	36	23	27	30	23
16	35				

The following table shows the number of revolutions of the inward discharging turbine wheel per minute, the column marked "Head," shows the number of feet head, the column marked "Diameter," shows the diameter of the wheel in inches.

Example.

Required, the number of revolutions per minute, of the inward discharging turbine wheel, the head being 10 feet, and the diameter being 60 inches—find 10 in the column marked "Head," opposite to this number in the table, and

No. 11.

Head.	DIAMETER.												
	24	30	36	42	48	54	60	66	72	78	84	90	96
4	122	98	81	70	61	54	49	44	40	37	35	33	30
5	137	109	91	78	68	60	54	49	45	42	39	36	34
6	149	120	100	85	75	66	60	54	50	46	42	40	37
7	160	129	107	92	81	71	64	58	53	49	46	43	40
8	173	138	115	98	86	76	69	62	57	53	49	46	43
9	184	147	122	105	92	81	73	66	61	56	52	49	46
10	194	154	128	110	97	86	77	70	64	59	55	51	48
11	203	162	135	115	101	90	81	73	67	62	57	54	50
12	212	169	141	121	106	94	84	77	70	65	60	56	53
13	220	176	147	126	110	98	88	80	73	67	63	59	55
14	229	183	153	131	114	102	91	83	76	70	65	61	57
15	237	189	158	135	118	105	94	86	79	72	67	63	59
16	245	196	163	140	122	109	98	89	81	75	70	65	61
17	252	201	168	144	126	112	100	91	84	77	72	67	63
18	260	207	173	148	130	115	103	94	86	80	74	69	65
19	266	213	177	152	133	118	106	97	88	82	76	71	66
20	274	219	182	156	137	121	109	100	91	84	78	73	68
21	281	224	187	160	140	124	112	102	93	86	80	75	70
22	288	229	191	164	143	127	114	105	95	88	82	76	72
23	294	234	195	167	146	131	117	107	97	90	84	78	73
24	300	239	199	170	149	133	119	109	99	92	85	79	74
25	307	245	204	175	153	136	121	111	102	94	87	82	76
26	313	249	208	178	156	138	124	113	104	96	89	83	78
27	318	254	212	182	159	141	127	116	106	98	91	85	79
28	324	259	216	185	162	144	129	118	108	100	92	86	81
29	330	263	219	188	164	146	131	120	110	101	94	88	82
30	335	268	223	191	167	149	134	123	112	103	95	89	84

under 60 in the column marked "Diameter," will be found 77 revolutions per minute.—*Answer.*

EXAMPLE.

Required, the number of revolutions per minute, of an inward discharging turbine wheel, the head being 30 feet, and the diameter being 48 inches—find 30 in the column marked "Head," opposite to this number in the table, and under 48 in the column marked "Diameter," will be found 167 revolutions per minute.—*Answer.*

The following tables show the horse power of the centre or inward discharging turbine water wheel, and also the horse power of the outward discharging turbine water wheel; these tables give the working power of the wheels. (See Note B.)—The columns marked "Head," show the number of feet head, the columns marked "Horse Power," show the horse power of the wheels under different heads, the column marked "Area,' shows the area of all the openings, which are 100 inches; the power of the wheel varies, as the area of all the openings—hence if any area is divided by 100, and multiplied by the number of horse power found in the table due to 100 inches area, the result will give the number of horse power due to that area.

EXAMPLE.

Required, the horse power of an outward discharging turbine water wheel, the effective head being 12 feet, and the area of all the openings being 300 inches—find 12 in the column marked "Head," opposite to this number in the column marked "Horse Power," will be found 13.4 horse power, which is the power due to 100 inches area, which multiplied by $\frac{300}{100}$, or 3.00, gives 40.2 horse power.—*Answer.*

EXAMPLE.

Required, the horse power of an outward discharging turbine wheel, the head being 10 feet, and the area of all the openings being 275 inches—find 10 in the column marked "Head," opposite to this number in the column marked "Horse Power," will be found 10.5, which multiplied by 2.75, gives 28.8 horse power.—*Answer.*

EXAMPLE.

Required, the horse power of an inward or centre discharging turbine water wheel, the head being 14 feet, and

No. 12.

CENTRE DISCHARGING.			OUTWARD DISCHARGING.		
Head.	Area.	Horse Power.	Head.	Area.	Horse Power.
4	100	1.5	4	100	2.5
5	"	2.1	5	"	3.8
6	"	2.7	6	"	4.6
7	"	3.4	7	"	5.8
8	"	4.2	8	"	7.4
9	"	5.1	9	"	8.8
10	"	5.9	10	"	10.5
11	"	6.9	11	"	11.7
12	"	7.8	12	"	13.4
13	"	8.8	13	"	15.1
14	"	10.0	14	"	17.2
15	"	10.9	15	"	19.2
16	"	12.1	16	"	21.0
17	"	13.2	17	"	23.1
18	"	14.4	18	"	25.2
19	"	15.6	19	"	27.3
20	"	16.9	20	"	29.5
21	"	18.1	21	"	31.6
22	"	19.5	22	"	33.8
23	"	20.8	23	"	36.2
24	"	22.2	24	"	38.6
25	"	23.6	25	"	41.1
26	"	25.0	26	"	43.6
27	"	26.5	27	"	45.6
28	"	28.0	28	"	48.3
29	"	29.5	29	"	50.7
30	"	31.0	30	"	53.6

the area of all the openings being 300 feet—find 14 in the column marked "Head," opposite to this number in the column marked "Horse Power," will be found 10 horse power, which multiplied by 3.00, gives 30 horse power.—*Answer.*

The following table shows the number of revolutions per minute, of the outward discharging turbine wheel under different heads—the column marked "Head," shows the number of feet head, the column marked "Diameter," shows the diameter of the wheel in inches.

No. 13.

Head.	DIAMETER.											
	24	30	36	42	48	54	60	66	72	78	84	90
4	110	88	72	61	55	48	44	40	36	33	30	29
5	122	98	81	70	61	54	49	44	41	37	35	32
6	134	108	89	77	67	60	54	49	44	41	37	36
7	145	116	96	83	72	64	58	52	48	45	41	39
8	155	124	103	89	78	69	62	56	51	47	44	41
9	165	132	110	94	82	73	66	60	55	50	47	44
10	173	139	116	99	86	77	69	63	58	53	49	46
11	182	145	121	104	91	80	72	66	61	56	52	48
12	190	155	126	108	95	84	77	69	63	58	54	52
13	198	158	132	113	99	88	79	72	66	61	56	53
14	105	164	137	117	102	91	82	74	68	63	58	55
15	212	170	141	121	106	94	85	77	71	65	60	56
16	220	176	146	125	110	97	88	80	73	67	62	58
17	226	181	151	130	113	100	90	82	75	70	65	61
18	233	186	155	133	116	103	93	84	77	72	66	62
19	239	191	160	137	119	106	95	87	80	73	68	63
20	246	196	163	140	123	109	98	89	82	75	70	65
21	251	201	167	144	125	112	100	91	84	77	72	67
22	257	206	171	147	128	114	103	93	86	79	73	68
23	263	211	175	150	131	117	105	95	88	81	75	70
24	269	215	179	153	134	119	108	97	90	82	76	72
25	275	220	183	157	137	122	110	100	91	84	78	73
26	280	224	187	160	140	124	112	102	93	86	80	75
27	285	228	190	164	142	127	114	104	95	87	82	76
28	290	232	194	166	145	129	116	106	97	89	83	77
29	296	236	197	169	148	131	118	108	98	91	84	79
30	300	240	200	172	150	133	120	109	100	92	86	80

EXAMPLE.

Required, the number of revolutions per minute of an outward discharging turbine wheel, the head being 7 feet, and the diameter of the wheel being 72 inches—find 7 in the column marked "Head," opposite to this number in the table, and under 72 in the column marked "Diameter," will be found 48 revolutions.—*Answer.*

EXAMPLE.

Required, the number of revolutions per minute, of an outward discharging turbine wheel, the head being 30 feet, and the diameter of the wheel being 48 inches—find 30 in the column marked "Head," opposite to this number in the table, and under 48 in the column marked "Diameter," will be found 150 revolutions.—*Answer.*

Note A.

An overshot water wheel 16 feet in diameter, requires a fall of $18\frac{1}{2}$ feet, and the per cent loss of the power due to $18\frac{1}{2}$ feet is about one third, or 35 per cent, according to the following statement—in $18\frac{1}{2}$ feet, there are 222 inches—

Allow 6 inches for clearance below the wheel, then 6 inches of the whole fall will be lost, or $\frac{6}{222}$ of the whole fall, or 027

Allow 2 feet for the head, which acts on the wheel by percussion, and hence $\frac{2}{3}$ of 2 feet loss, or $\frac{16}{222}$ of the whole fall, or 071

On a well calculated wheel, the water begins to empty from the buckets at about 5 feet from the bottom of the wheel, hence $\frac{5}{4}$ of a foot loss, or $\frac{15}{222}$ of the whole fall, or 067

The water in the buckets on the top of the wheel will be about 4 inches deep—the bucket is 12 inches deep—then 8 inches, and half of four, makes 10 inches loss of the whole fall, or $\frac{10}{22}$, or 045

The velocity of the wheel, and also the water, is five feet per second—the theoretical velocity due to $18\frac{1}{2}$ feet head is 35 feet per second, nearly—it is a well known law that the effect varies as the relative volocity, hence $\frac{5}{35}$ of the whole power, or .145

Total per cent loss .355

It is found by a great number of observations, that when the wheel runs 5 feet per second, the water should enter the buckets with a velocity of 8 feet per second—it is also found that it requires 2 feet head in practice, to impel the water with a velocity of 8 feet per second—hence it is necessary that the ordinary head on overshot and breast wheels, should be two feet.

The overshot and breast water wheels, are calculated to run 5 feet per second, which is a good geering velocity, and it appears to be the proper velocity for overcoming the inertia of the wheel when loaded. The head is calculated to be 2 feet, and the depth of the bucket 12 inches. There are on well constructed breast wheels two or three gates to let the water on the wheel, the first gate being under a head of 18 to 24 inches, from which the wheel is always supplied except in case of low water, when the lower gates are opened as the head is drawn down: by this arrangement, the reservoir can be drawn down several feet, but with the overshot wheel, the head cannot be drawn down but a few inches; this palpable advantage which the breast wheel possesses over the overshot, has caused it to be more generally introduced; when the reservoir is small, or when the head cannot be drawn down, the overshot wheel is generally preferred, as the first cost is a little less than the breast wheel.

Note B.

Sufficient allowance has been made for loss power in the tables, showing the horse power of the outward and inward discharging turbine water wheels; and also, due allowance has been made in the tables showing the required area of all the openings, to drive Corn and Flour Mills under different heads, and Cotton Machinery. If the heads represented in the tables always remained constant, the wheels would be well calculated, as the surplus power is sufficient to always insure a good supply; if the location should be subject to back water, or if the head should be liable to be drawn down, due allowanee should be made. The table showing the depth of water in wheel pits, should be carefully examined when laying out the dimensions of the wheel pit and race: in ordinary cases two to three feet should be deducted from the whole fall; let the remainder be considered the effective head.

STEAM POWER.

STEAM POWER.

THE following table shows the horse power of the plain cylindrical boiler, with one return flue, under a pressure

No. 1.

Length.	DIAMETER.										
	12	18	24	30	36	42	48	54	60	66	72
10	.6	1.4	2 6	4.1	5.8	8.0	10.4	13.2	16.3	19.8	23.5
11	.7	1.6	2.8	4.5	6.4	8.8	11.5	14.5	17.9	21.8	25.9
12	.78	1.7	3 1	4.9	7.0	9 6	12.5	15.8	19.6	23.8	28.2
13	.84	1.9	3.4	5.3	7.6	10.4	13.6	17.1	21.2	25.8	30.6
14	.91	2.0	3.6	5.8	8.2	11.2	14.6	18.4	22.9	27.7	32.9
15	.97	2 2	3 9	6.2	8 8	12 0	15.7	19.8	24.5	29.7	35.3
16	1.0	2.3	4.1	6 6	9.4	12.8	16.7	21.1	26.1	31.7	37.6
17	1.1	2 4	4 4	7.0	10.0	13.6	17.7	22.4	27.8	33.7	40.0
18	1 2	2.6	4.7	7.4	10.6	14.4	18.8	23.7	29.4	35.7	42.4
19	1.2	2.7	4.9	7.8	11.1	15.2	19.8	25.0	31.0	37.7	44.7
20	1 3	2.9	5.2	8.3	11.7	16.0	20.9	26.4	32.7	39.7	47.1
21	1.3	3.0	5 5	8.7	12.3	16.8	21.9	27.7	34 3	41.6	49.4
22	1.4	3 2	5 7	9.1	12.9	17 6	23.0	29.0	35.9	43.6	51.8
23	1.4	3.3	6.0	9.5	13.5	18.4	24.0	30.3	37.6	45.6	54.1
24	1 5	3.5	6.2	9.9	14 1	19.2	25 1	31.6	39.2	47.6	56.5
25	1.6	3.6	6.5	10.3	14.7	20 0	26.1	33.0	40.9	49.6	58.9
26	1.6	3.8	6.8	10.7	15.3	20.8	27 2	34.3	42.5	51.6	61.2
27	1.7	3·9	7.0	11.2	15·9	21.6	28.2	35.6	44.1	53.5	63.6
28	1 8	4.1	7.3	11.6	16.4	22.4	29.3	36.9	45.8	55.5	65.9
29	1 8	4 2	7.6	12.0	17.0	23.2	30 3	38.2	47.4	57.5	68.3
30	1.9	4.4	7.8	12.4	17.6	24.0	31.4	39.6	49.0	59.5	70.6
31	2.0	4.5	8.1	12.8	18.2	24 8	32.4	40 9	50.7	61.5	73.0
32	2.0	4.7	8.3	13 2	18.8	25 6	33.5	42.2	52.3	63.5	75.3
33	2.1	4.8	8.6	13.6	19.4	26.4	34.5	43.5	53.9	65.5	77.7
34	2 2	4.9	8.9	14.1	20.0	27.2	35.5	44.8	55.6	67.4	80.1
35	2.2	5.1	9.1	14.5	20.6	28.0	36.6	46 2	57.2	69.4	82.4
36	2.3	5.2	9.4	14 9	21.2	28.8	37.6	47.5	58.8	71.4	84.8
37	2.4	5.4	9.6	15.3	21.7	29.6	38.7	48 8	60.5	73.4	87.1
38	2.4	5.5	9.9	15.7	22.3	30.4	39.7	50.1	62.1	75.4	89.5
39	2.5	5.7	10.2	16.1	22.9	31.2	40.8	51.4	63.8	77.4	91.8
40	2.6	5.8	10.4	16.6	23.5	32.1	41.8	52.8	65.4	79·4	94.2

from 50 to 60 pounds per square inch—the column marked "Length," shows the length of the boiler in feet, the column marked "Diameter," shows the diameter of the boiler in inches.

EXAMPLE.

Required, the horse power of a boiler, the length being 28 feet, and the diameter being 48 inches—find 28 in the column marked "Length," opposite to this number in the table, and under 48 in the column marked "Diameter," will be found 29.3 horse power.—*Answer.*

EXAMPLE.

Required, the number of horse power of a boiler, the length being 18 feet, and the diameter being 24 inches—find 18 in the column marked "Length," opposite to this number in the table, and under 24 in the column marked "Diameter," will be found 4.7 horse power.—*Answer.*

The following table shows the usual consumption of coarse Anthracite Coal per day by different sized engines—the column marked "Horse Power," shows the horse power of the engines, the column marked "Pounds Coal," shows the number of pounds consumed per day (12 hours).

EXAMPLE.

Required, the number of pounds of Anthracite Coal per day, to supply an engine working 40 horse power—find 40 in the column marked "Horse Power," opposite to this number in the column marked "Pounds Coal," will be found 1680 pounds.—*Answer.*

EXAMPLE.

Required, the number of pounds of Anthracite Coal per

day, to supply an engine working 100 horse power—find 100 in the column marked "Horse Power," opposite to this number in the column marked "Pounds Coal," will be found 4210 pounds.—*Answer.*

No. 2.

Horse Power.	Pounds Coal.	Horse Power.	Pounds Coal.	Horse Power.	Pounds Coal.
4	168	38	1596	70	2940
6	252	40	1680	72	3024
8	336	42	1764	74	3108
10	420	44	1848	76	3192
12	504	46	1932	78	3276
14	588	48	2016	80	3360
16	672	50	2100	82	3444
18	756	52	2184	84	3528
20	840	54	2268	86	3612
22	924	56	2352	88	3696
24	1008	58	2436	90	3780
26	1092	60	2520	92	3864
28	1176	62	2604	94	3948
30	1260	64	2688	96	4032
32	1344	66	2772	98	4126
34	1428	68	2856	100	4200
36	1512				

The following table is calculated principally for the Southern States, where the Southern Pine is used for fuel instead of Coal—the column marked "Horse Power," shows the number of horse power the engine is working, the column marked "Cords," shows the number of cords that the engine consumes per day (12 hours), the column marked "Hours," shows the number of hours per day, which the engine is supposed to run.

EXAMPLE.

Required, the number of cords of Southern Pine to drive three run of $4\frac{1}{2}$ feet stones grinding corn, the number of

horse power required being about 45—find 45 in the column marked "Horse Power," opposite to this number in the column marked "Cords," will be found $5\frac{1}{2}$ cords.—*Answer.*

EXAMPLE.

An engine is working 25 horse power, required, the number of cords the engine will consume per day (12 hours)—find 25 in the column marked "Horse Power," opposite to this number in the column marked "Cords," will be 3 cords.—*Answer.*

No. 3.

Horse Power.	Cords.	Hours.	Horse Power.	Cords.	Hours.
4	$\frac{1}{2}$	12	45	$5\frac{1}{2}$	"
6	$\frac{3}{4}$	"	50	6	"
8	1	"	55	$6\frac{1}{2}$	"
10	$1\frac{1}{4}$	"	60	$7\frac{1}{4}$	"
12	$1\frac{1}{2}$	"	65	8	"
14	$1\frac{3}{4}$	"	70	$8\frac{1}{2}$	"
16	2	"	75	$9\frac{1}{4}$	"
18	$2\frac{1}{4}$	"	80	$9\frac{3}{4}$	"
20	$2\frac{1}{2}$	"	85	$10\frac{1}{2}$	"
25	3	"	90	11	"
30	$3\frac{1}{2}$	"	95	$11\frac{3}{4}$	"
35	$4\frac{1}{4}$	"	100	$12\frac{1}{2}$	"
40	$4\frac{3}{4}$	"			

The following table shows the number of cubic feet of water per hour, that high pressure engines require per horse power: the calculated power of engines will be taken for this table, instead of the actual power, as this table shows nearly the theoretical quantity of water required—the column marked "Horse Power," shows the calculated power of the engine, the column marked "No. of Hours," shows the number of hours the engine is in operation.

No. 4.

Horse Pow	NUMBER OF HOURS.											
	1	2	3	4	5	6	7	8	9	10	11	12
10	11.0	22.0	33.0	44.0	55.0	66.0	77.0	88.0	99.0	110	121.0	132.0
11	12 1	24.2	36 3	48.4	60.5	72.6	84.7	96.8	108.9	121	133.1	145.2
12	13 2	26.4	39.6	52.8	66.0	79.2	92.4	105.6	118.8	132	145.2	158.4
13	14 3	28.6	42 9	57.2	71 5	85.8	100.1	114.4	128.7	143	157 3	171.6
14	15.4	30.8	46.2	61.6	77 0	92.4	107.8	123.2	138.6	154	169.4	184.8
15	16.5	33.0	49.5	66.0	82.5	99.0	115.5	132.0	148.5	165	181.5	198.0
16	17 6	35 2	52.8	70.4	88.0	105.6	123.2	140.8	158.4	176	193.6	211.2
17	18.7	37.4	56.1	74 8	93.5	112.2	130.9	149.6	168.3	187	205.7	224.4
18	19.8	39.6	59.4	79.2	99 0	118.8	138.6	158.4	178.2	198	217.8	237.6
19	20.9	41.8	62.7	83.6	104.5	125.4	146.3	167.2	188.1	209	229.9	250.8
20	22.0	44.0	66.0	88.0	110.0	132 0	154.0	176.0	198.0	220	242.0	264 0
21	23.1	46.2	69.3	92.4	115.5	138 6	161.7	184.8	207.9	231	254.1	277.2
22	24.2	48.4	72.6	96.8	121.0	145.2	169 4	193.6	217 8	242	266.2	290.4
23	25.3	50 6	75.9	101.2	126 5	151.8	177.1	202.4	227.7	253	278.3	303.6
24	26.4	52.8	79.2	105.6	132.0	158.4	184.8	211.2	237.6	264	290.4	316.8
25	27.5	55.0	82.5	110.0	137.5	165.0	192.5	220.0	247.5	275	302.5	330.0
26	28.6	57.2	85.8	114.4	143.0	171.6	200.2	228.8	257.4	286	314.6	343.2
27	29.7	59.4	89.1	118.8	148.5	178.2	207 9	237.6	267.3	297	326.7	356.4
28	30.8	61.6	92.4	123 2	154.0	184.8	215.6	246.4	277 2	308	338 8	369.6
29	31.9	63.8	95.7	127.6	159 5	191.4	223 3	255.2	287.1	319	350.9	382.8
30	33 0	66.0	99.0	132.0	165.0	198.0	231.0	264.0	297.0	330	363.0	396.0
31	34 1	68 2	102.3	136.4	170 5	204 6	238.7	272 8	306.9	341	375.1	409.2
32	35.2	70 4	105.5	140.8	176.0	211.2	246.4	281 6	316.8	352	387.2	422.4
33	36.3	72.6	108.9	145.2	181.5	217.8	254.1	290.4	326.7	363	399.3	435.6
34	37 4	74.8	112 2	149.6	187.0	224.4	261.8	299.2	336.6	374	411 4	448.4
35	38.5	77.0	115.5	154.0	192.5	231.0	269.5	308.0	346 5	385	423.5	462.0
36	39.6	79.2	118.8	158.4	198.0	237.6	277.2	316.8	356.4	396	435.6	475.2
37	40.7	81.4	122 1	162.8	203 5	244.2	2-4.9	325 6	366.3	407	447.7	488.4
38	41.8	83.6	125 4	167 2	209.0	250.8	292.6	334.4	376.2	418	459.8	501.6
39	42.9	85.8	128.7	171.6	214.5	257 4	300.3	343.3	386.1	429	471.9	514.8
40	44.0	88.0	132.0	176.0	220.0	264.0	308.0	352.0	396.0	440	484.0	528.0
41	45.1	90.2	135 3	180.4	225.5	270.6	315 7	360.8	405.9	451	496.1	541.2
42	46 2	92.4	138 6	184.8	231.0	277.2	323.4	369.6	415.8	462	508,2	554.4
43	47.3	94.6	141.9	189.2	236.5	283.8	331.1	378.4	425.7	473	520 3	567.6
44	48.4	96.8	145 2	193.6	242.0	290.4	338.8	387 2	435.6	484	532.4	580.8
45	49.5	99.0	148.5	198.0	247.5	297.0	346 5	396.0	445.5	495	544.5	594.0
46	50.6	101.2	151.8	202.4	253.0	303.6	354.2	404 8	455.5	506	556.6	607.2
47	51.7	103.4	155.1	206.8	258.5	310.2	361.9	413.6	465.3	517	568.7	620.4
48	52.8	105.6	158.4	211 2	264.0	316.8	369.6	422 4	475.2	528	580.8	633.6
49	53.9	107.8	161.7	215.6	269.0	323.4	377.3	431.2	485.1	539	592.9	646.8
50	55.0	110.0	165.0	220.0	275.0	330.0	385.0	440.0	495.0	550	605.0	660.0
51	56.1	112.2	168.3	224 4	280.5	336.6	392.7	448.8	504.9	561	617.1	673.2
52	57 2	114.4	171.6	228 8	286.0	343.2	400.4	457.6	514.8	572	629.2	686.4
53	58.3	116.6	174.9	233.2	291.5	349.8	408.1	466.4	524 7	583	641.3	699.6
54	59.4	118.8	178.2	237.6	297.0	356.4	415 8	475.2	534 6	594	653.4	712.8
55	60.5	121.0	181.5	242.0	302.5	363 0	423 5	484.0	544.5	605	665 5	726.0

No. 4.—*Continued.*

Horse Pow	NUMBER OF HOURS.											
	1	2	3	4	5	6	7	8	9	10	11	12
56	61.6	123.2	184.8	246.4	308 0	369.6	431.2	492.8	554.4	616	677.6	739 2
57	62.7	125.4	188.1	250.8	313.5	376 2	438.9	501.6	564.3	627	689.7	752.4
58	63.8	127.6	191.4	255.2	319.0	382.8	446.6	510.4	574.2	638	701 8	765.6
59	64.9	129 8	194.7	259.6	324.5	389 4	454 3	519.2	584.1	649	713.9	778.8
60	66.0	132.0	198.0	264.0	330.0	396.0	462 0	528.0	594 0	660	726.0	792.0
61	67.1	134.2	201.3	268.4	335 5	402.6	469.7	536.8	603.9	671	738.1	805.2
62	68.2	136.4	204.6	272.8	341.0	409.2	477 4	545.6	613.8	682	750.2	818.4
63	69.3	138.6	207.9	277.2	346.5	415.8	485.1	554.4	623.7	693	762.3	831.6
64	70.4	140.8	211.2	281.6	352.0	422 4	492.8	563.2	633.6	701	774 4	844.8
65	71.5	143.0	214.5	286.0	357 5	429 0	500 5	572.0	643.5	715	786.5	858 0
66	72.6	145 2	217.8	290.0	363.0	435.6	508 2	580.8	653.4	726	798.6	871.2
67	73.7	147.4	221.1	294.8	368.5	442.2	515 9	589.6	663.3	737	810.7	884 4
68	74.8	149.6	224.4	299.2	374.0	448.8	523.6	598 4	673 2	748	822.8	897.6
69	75.9	151.8	227.7	303.6	379 5	455 4	531 3	607.2	683.1	759	834.9	910.8
70	77.0	154.0	231.0	308.0	385.0	462.0	539.0	616.0	693.0	770	847.0	924 0
71	78.1	156.2	234 3	312.4	390.5	468.6	546.7	624.8	702.9	781	859.1	937.2
72	79.2	158.4	237.6	316.8	396.0	475.2	554.4	633.6	712.8	792	871.2	950.4
73	80.3	160.6	240.9	321.2	401.5	481.8	562.1	642.4	722 7	803	883.3	963 6
74	81.4	162.8	244.2	325.6	407.0	488.4	569.8	651.2	732.6	814	895 4	976.8
75	82.5	165 0	247.5	330.0	412.5	595.0	577 5	660.0	742.5	825	997.5	990.0
76	83.6	167.2	250.8	33 4.4	418.0	501.6	585 2	668.8	752 4	736	919 6	1003.2
77	84.7	169.4	254 1	338 8	423.5	508.2	592.9	677 6	762 3	847	931.7	1016 4
78	85.8	171.6	257.4	343.2	429.0	514.8	600.6	686.4	772.2	858	943 8	1029.6
79	86.9	173 8	260.7	347.6	434.5	521.4	608 3	695.2	782.1	869	955.9	1042.8
80	88.0	176.0	264.0	352.0	440.0	528.0	616.0	704.0	792.0	880	968 0	1056 0
81	89.1	178.2	267.0	356.4	445.5	53 4.6	623.7	712.8	801.9	891	980.1	1069.2
82	90 2	180.4	270 6	350.8	451.0	541.2	631.4	721.6	811.8	902	992.2	1082 4
83	91 3	182.6	273.9	365.2	456.5	547.8	639.1	730.4	821 7	913	1004.3	1095.6
84	92.4	184.8	277.2	369.6	462.0	554.4	646 8	739.2	831.6	924	1016.4	1108 8
75	93.5	187.0	280.5	374.0	467.5	561.0	654.5	748.0	841 5	935	1028.5	1122.0
86	94.6	189.2	283.8	378.4	473.0	567.6	662.2	756.8	851 4	946	1040.6	1135.2
87	95.7	191.4	287.1	382 8	478.5	574.2	669.9	765.6	861 3	957	1052.7	1148.4
88	96 8	193.6	290.4	387.2	484.0	580.8	677.6	774 4	871.2	968	1064 8	1161.6
99	97.9	195.8	293.7	391.6	489.0	587.4	685.3	783.2	881.1	970	1076.0	1174 8
90	99.0	198.0	297.0	396 0	495 0	594.0	693.0	792.0	891 0	999	1089 0	1188.0
91	100.1	200 2	300.3	400.4	500.5	600.6	700.7	800 8	900 9	1001	1101.1	1201.2
92	101.2	202.4	303 6	404.8	506.0	607.2	708.4	809.6	910 8	1012	1113.2	1214.4
93	102.3	204.6	306.9	409.2	511.5	613.8	716.1	818.4	920.7	1023	1125.3	1227.6
94	103.4	206.8	310.2	413.6	517.0	620.4	723.8	827.2	930.6	1034	1137.4	1210.8
95	104.5	209.0	313.5	418 0	522.5	627 0	731 5	836.0	940 5	1045	1149 5	1251.0
96	105.6	211.2	316.8	422.4	528.0	633.6	739.2	844.8	950.4	1056	1161.6	1267.2
97	106.7	213 4	320.1	426.8	533.5	640.2	746 9	853.6	960.3	1067	1173.7	1280.4
98	107.8	215.6	323.4	431.2	539.0	646.8	754.6	862.4	970 2	1078	1185.8	1293.6
99	108.9	217.8	326.7	435.6	544.5	653.4	762 3	871.8	980.1	1089	1197.9	1306.8
100	110.0	220.0	330.0	440.0	550.0	660.0	770.0	880.0	990.0	1100	1210 0	1320 0

EXAMPLE.

Required, the number of cubic feet of water per day, to supply an engine, the calculated power of which is 40 horse power—find 40 in the column marked "Horse Power," opposite to this number in the table, and under 12 in the column marked "Hours," will be found 528 cubic feet of water.—*Answer.*

EXAMPLE.

Required, the number of cubic feet of water per day (12 hours), to supply an engine, the calculated power being 90 horse power—find 90 in the column marked "Horse Power," opposite to this number in the table, and under 12 in the column marked "Hours," will be found 1188 cubic feet.—*Answer.*

The following table shows the mean pressure of steam upon piston, when acting expansively—the column marked "Pressure," shows the pressure of the steam when it enters the cylinder, the column marked "Cut off," shows what portion of the whole length of the cylinder the piston has moved when the steam is cut off.

EXAMPLE.

The effective pressure of steam upon piston, before it is cut off, or at the commencement of the stroke, is 60 pounds per inch; the steam being cut off at $\frac{4}{8}$ the length of the stroke: required, the mean effective pressure—find 60 in the column marked "Pressure," opposite to this number in the table, and under $\frac{4}{8}$ in the column marked "Cut off," will be found 51.12 pounds pressure; in ordinary calculations the fractions in this table may be omitted; if the fraction exceeds half a unit, add one to the pressure; suppose the pressure was 51.7, then add one to 51 which gives 52, but if the

pressure was 51.4, the fraction can be omitted, which gives 51 pounds pressure.—*Answer.*

EXAMPLE.

The effective pressure at the commencement of the stroke is 120, the steam being cut off at $\frac{4}{8}$ the length of the stroke; required, the mean effective pressure—find 120 in the column marked "Pressure," opposite to this number in the table, and under $\frac{4}{8}$ in the column marked "Cut off," will be found 102.24 pounds mean effective pressure.—*Answer.*

No. 5.

Pressure.	CUT OFF.						
	1-8	2-8	3-8	4-8	5-8	6-8	7-8
10	4.16	6.07	7.54	8.52	9.19	9 67	9.92
11	4.57	6.67	8.29	9.37	10.10	10.63	10.91
12	4.99	7.28	9.04	10.22	11.02	11 60	11.90
13	5.40	7.89	9.80	11.07	11.94	12.57	12.89
14	5.82	8.49	10 55	11 92	12.86	13.53	13.88
15	6.24	9.10	11 31	12.78	13 78	14.50	14 88
16	6.65	9.71	12.06	13.63	14.70	15.47	15 87
17	7.07	10.31	12.81	14.48	15.62	16.43	16.86
18	7.48	10.92	13.57	15.33	16.54	17.40	17.85
19	7.90	11.53	14.32	16.18	17.46	18 37	18.84
20	8.32	12.14	15.08	17.04	18.38	19.34	19.84
21	8.73	12.74	15 83	17.89	19.29	20.30	20.83
22	9.15	13.35	16.58	18.74	20.21	21.27	21.82
23	9.56	13.96	17.34	19.59	21.13	22.24	22.81
24	9.98	14.56	18.09	20.44	22.05	23.20	23.80
25	10.40	15.17	18.85	21.30	22.97	24.17	24.80
26	10.81	15.78	19.60	22.15	23.89	25.14	25.79
27	11.23	16.38	20.35	23.00	24.81	26.10	26.78
28	11.64	16.99	21.11	23.85	25.73	27.07	27.77
29	12.06	17.60	21.86	24.70	26.65	28 04	28.76
30	12.48	18.21	22 62	25.56	27.57	29.01	29.76
31	12.89	18.81	23.37	26.41	28.48	29.97	30.75
32	13.31	19.42	24 12	27.26	29.40	30.94	31.74
33	13.72	20.03	24.88	28.11	30 32	31.91	32.73
34	14.14	20.63	25.63	28.96	31.24	32.87	33.72
35	14.56	21.24	26.39	29.82	32.16	33.84	34.72
36	14.97	21.85	27.14	30.67	33.08	34.81	35.71
37	15.39	22.45	27 89	31.52	34.00	35.77	36.70
38	15.80	23.06	28.65	32.37	34.94	36.74	37.69
39	16.22	23.67	29.40	33.22	35.84	37.71	38.68

No. 5.—*Continued.*

Pressure.	CUT OFF.						
	1-8	2-8	3-8	4-8	5.8	6-8	7-8
40	16.64	24.28	30.16	34.08	36.76	38.68	39.68
41	17.05	24.88	30.91	34.93	37.67	39.64	40.67
42	17.47	25.49	31.66	35.78	38 59	40 61	41.66
43	17.88	26.10	32 42	36.63	39.51	41.58	42.15
44	18.30	26.70	33.17	37.48	40.43	42.54	43.64
45	18.72	27.31	33.93	38.34	41.35	43.51	44.64
46	19.13	27.92	34.68	39.19	42.27	44.48	45.63
47	19.55	28.52	35 43	40.04	43.19	45.44	46 62
48	19.96	29.13	36.19	40.89	44.11	46.41	47.61
49	20.38	29.74	36.94	41.74	45.03	47.38	48.60
50	20.80	30.35	37.70	42.60	45.95	48.35	49.60
51	21.21	30.95	38.45	43.45	46.86	49.31	50.59
52	21 63	31.56	39.20	44.30	47.78	50.28	51.58
53	22.04	32.17	39.96	45.15	48.70	51.25	52.57
54	22.46	32.77	40 71	46.00	49 62	52.21	53 56
55	22.88	33.38	41.47	46.86	50.54	53.18	54.56
56	23.29	33.99	42.22	47.71	51.46	54.15	55.55
57	23.71	34.59	42.97	48.56	52 38	55.11	56.54
58	24.12	35.20	43.73	49.41	53.30	56.08	57.53
59	24.54	35.81	44.48	50 26	54 22	57.05	58.52
60	24.96	36.42	45.24	51.12	55.14	58.02	59.52
61	25.37	37.02	45.99	51.97	56.05	58.98	60 51
62	25.79	37.63	46.74	52.82	56.97	59.95	61.51
63	26.20	38.24	47.50	53.67	57.89	60.92	62 49
64	26.62	38.84	48.25	54.52	58.81	61.88	63.48
65	27.04	39.45	49.01	55 38	59.73	62.85	64.48
66	27.45	40.06	49 76	56.23	60.65	63.82	65.47
67	27.87	40.66	50.51	57.08	61 57	64.78	66.46
68	28.28	41.27	51.27	57.93	62.49	65.75	67.45
69	28.70	41.88	52.02	58.78	63.41	66.72	68.44
70	29.12	42.49	52.78	59.64	64.33	67.69	69.44
71	29.53	43.09	53 53	60.49	65.24	68.65	70.43
72	29.95	43.70	54.28	61.34	66.16	69.62	71.42
73	30.36	44.31	55.04	62.19	67.08	70.59	72.41
74	30.78	44.91	55.79	63.04	68.00	71.55	73.40
75	31.20	45.52	56 55	63.90	68.92	72.52	74.40
76	31.61	46.13	57.30	64.75	69.84	73.49	75.39
77	32.03	46.73	58.05	65 60	70.76	74.45	76.38
78	32.44	47.34	58.81	66.45	71.68	75.42	77.37
79	32.86	47.95	59.56	67.30	72.60	76.39	78.36
80	33.28	48.56	60 32	68 16	73 52	77.36	79.36
81	33.69	49.16	61.07	69 01	74 43	78.33	80.35
82	34.11	49.77	61.82	69 86	75.35	79.29	81.34
83	34 52	50.38	62 58	70.71	76.27	80.26	82.33
84	34.94	50.98	63 33	71.56	77.19	81.22	83 32

No. 5.—*Continued.*

Pressure.	CUT OFF.						
	1-8	2-8	3-8	4-8	5-8	6-8	7-8
85	35.36	51.59	64.09	72.42	78 11	82 19	84.32
86	35.77	52.20	64.84	73.27	79.03	83.16	85.31
87	36.19	52.80	65.59	74.12	79.95	84.12	86.30
88	36.60	53.41	66.35	74.97	80.87	85.09	87.29
89	37.02	54.02	67.10	75.82	81.79	86.06	88.28
90	37 44	54.63	67.86	76.68	82.71	87.03	89.28
91	37.85	55.23	68.61	77.53	83.62	87.99	90.27
92	38.27	55.84	69.36	78.38	84.54	88.96	91.26
93	38.68	56.45	70.12	79.23	85.46	89.93	92.25
94	39.10	57.05	70.87	80.08	86.38	90.89	93.24
95	39.52	57.66	71.63	80.94	87.30	91.86	94.24
96	39.93	58.27	72.38	81.79	88.22	92 83	95.23
97	40.35	58.87	73.13	82.64	89.14	93.79	96.22
98	40.76	59.48	73.89	83.49	90.06	94.76	97.21
99	41.18	60.09	74.64	84.34	90.98	95.73	98.20
100	41.60	60.70	75.40	85.20	91.90	96.70	99.20
101	42.01	61.30	76.15	86.05	92.81	97.66	100.19
102	42 43	61.91	76.90	86.90	93.73	98.63	101.18
103	42.84	62.52	77.66	87.75	94.65	99.60	102.17
104	43.26	63.12	78.41	88.60	95.57	100.56	103.16
105	43.68	63.73	79.17	89.46	96.49	101.53	104.16
106	44.09	64.34	79.92	90.31	97.41	102.50	105.15
107	44.51	64.94	80.67	91.16	98.33	103.46	106.14
108	44 92	65.55	81.43	92.01	99.25	104.43	107.13
109	45.34	66 16	82.18	92.86	100.17	105.40	108.12
110	45.76	66.77	82.94	93.72	101.09	106 37	109.12
111	46.17	67.37	83.69	94.57	102.00	107.33	110.11
112	46.59	67.98	84.44	95.42	102.92	108 30	111.10
113	47.00	68.59	85.20	96.27	103.84	109.27	112.09
114	47.42	69.19	85 95	97.12	104 76	110.23	113.08
115	47.84	69.80	86.71	97.98	105 68	111.10	114,08
116	48.25	70.41	87.46	98 83	106 60	112.17	115 07
117	48.67	71.01	88.21	99 68	107 52	113.13	116 06
118	49.08	71.62	88.97	100.53	108.44	114.10	117.05
119	49.50	72.23	89·72	101.38	109.36	115.07	118.04
120	49.92	72 84	90 48	102.24	110.28	116.04	119.04

The following table shows the horse power of the condensing and non-condensing engines—the column marked "Pressure," shows the effective pressure per square inch upon piston, the column marked "Diameter," shows the diameter of the cylinder in inches; the piston is calculated to move 100 feet per minute, the power of the engine varies as the velocity of the piston; hence, if any velocity is divided by 100, and multiplied by the number of horse power found in the table due to 100, the result will give the number of horse power due to that velocity.

EXAMPLE.

Required, the horse power of an engine, the diameter of the cylinder being 14 inches, the effective pressure being 50 pounds per square inch, and the velocity of the piston being 300 feet per minute—find 14 in the column marked "Diameter," opposite to this number in the table, and under 50 in the column marked "Pressure," will be found 23.32, which is the horse power of the engine when the piston moves 100 feet per minute; as the piston moves 300 feet, multiply 23.32 by $\frac{300}{100}$ or 3.00, which gives 69.96 horse power.—*Answer.*

EXAMPLE.

Required, the horse power of an engine, the diameter of the cylinder being 18 inches, the effective pressure per inch being 60 pounds, and the velocity of the piston being 275 feet per minute—find 18 in the column marked "Diameter," opposite to this number in the table, and under 60 in the column marked "Pressure," will be found 46.26, which multiplied by 2.75, gives 127.21 horse power.—*Answer.*

No. 6.

Diameter.	PRESSURE.									
	10	11	12	13	14	15	16	17	18	19
8	1.52	1.67	1.83	1.98	2.13	2.28	2.44	2 59	2.74	2.89
9	1.93	2.12	2.31	2.51	2.70	2.89	3.08	3.27	3.46	3.66
10	2.38	2.62	2.85	3.09	3.33	3.57	3.80	4.04	4.28	4.52
11	2.88	3.16	3.45	3.74	4.03	4.32	4.61	4.89	5.18	5.47
12	3.43	3.77	4.11	4.45	4.79	5.14	5.48	5.82	6.17	6.51
13	4.02	4.42	4.82	5.22	5.63	6.03	6.43	6 83	7 24	7.64
14	4.66	5.13	5.59	6.06	6.52	6.99	7.46	7.92	8.39	8.86
15	5.35	5.89	6.42	6.96	7.49	8.03	8.56	9.10	9.63	10.17
16	6.09	6.70	7.31	7.92	8.53	9.14	9.75	10.35	10.97	11.57
17	6.87	7.56	8.25	8.94	9.63	10.31	11.00	11.68	12 37	13.06
18	7.71	8.48	9.25	10.02	10.79	11.56	12.33	13 11	13.88	14.65
19	8.59	9.45	10.31	11.17	12.02	12.88	13.74	14 60	15.46	16.32
20	9.52	10.47	11.42	12.37	13 32	14.28	15.23	16.18	17.13	18.08
21	10.49	11.54	12.59	13.64	14.69	15.74	16 79	17.84	18.89	19.94
22	11.52	12.67	13.82	14.97	16.12	17.28	18.43	19.58	20.73	21.88
23	12.59	13.84	15.10	16.36	17.62	18.88	20.14	21.40	22.66	23.92
24	13.70	15.07	16.45	17.82	19.19	20.56	21.93	23.31	24.67	26.04
25	14.87	16.36	17.85	19 33	20.82	22.31	23.80	25.28	26.77	28 26
26	16.09	17.69	19.30	20.91	22.52	24.13	25.74	27.35	28.96	30.56
27	17.35	19.08	20.82	22.55	24.29	26.02	27.76	29.49	31.23	32.96
28	18.66	20.52	22 39	24.25	26 12	27.98	29.85	31.72	33.58	35.45
29	20.01	22.01	24.01	26.01	28.02	30.02	32.02	34.02	36.02	38.02
30	21.42	23.56	25.70	27.84	29.98	32.13	34.27	36.41	38.55	40.69
31	22.87	25.15	27.44	29.73	32.01	34.30	36.59	38.88	41.16	43.45
32	24.37	26.80	29 24	31.68	34 11	36.55	38.99	41.43	43.86	46.30
33	25.91	28.50	31.10	33.69	36.28	38.87	41.46	44.06	46.65	49.24
34	27.51	30.26	33.01	35.76	38.51	41.26	44.02	46.77	49.52	52.27
35	29.15	32.07	34.98	37.99	40.81	43 73	46.64	49.56	52.47	55.39
36	30.84	33.92	37.01	40.09	43.18	46.26	49.34	52.43	55.51	58 60
37	32.58	35.83	39.09	42.35	45.61	48.87	52.12	55.38	58.64	61.90
38	34 36	37.80	41.23	44.67	48.11	51.54	54.98	58.42	61.85	65.29
39	36.20	39.82	43 44	47.06	50.68	54.30	57.92	61.54	65.16	68.78
40	38.08	41.88	45.69	49.50	53.31	57.12	60.92	64.73	68.54	72.35
41	40.01	44.00	48.00	52.00	56.00	60.00	64.00	68.01	72 01	76.01
42	41.98	46.18	50.37	54.57	58.77	62.97	67.17	71.36	75.56	79.76
43	44.01	48.40	52.80	57.20	61.61	66.00	70.40	74.81	79.21	83.61
44	46.07	50.68	55.29	59.89	64.50	69.11	73.72	78.32	82.93	87.54
45	48.19	53.01	57.83	62.65	67.47	72.29	77.11	81.92	86.74	91.56
46	50.36	55.39	60.43	65.46	70.50	75.54	80,57	85 61	90.64	95.68
47	52.57	57.83	63.08	68.34	73.60	78.85	84.11	89.37	94.63	99.88
48	54.83	60.31	65.79	71.28	76.76	82.24	87,73	93.21	98.69	104.18
49	57.14	62.85	68.57	74.28	79.99	85.71	91.42	97.14	102.85	108.56
50	59.50	65.45	71.40	77.35	83.30	89.25	95.20	101.15	107.10	113.05
51	61.90	68.09	74.28	80.47	86.66	92.85	99.04	105.23	111.42	117.61
52	64.35	70.78	77.22	83.66	90.09	96,53	102.96	109.40	115.83	122.27
53	66.85	73.53	80 22	86.90	93.59	100.27	106.96	113.64	120.33	127.01
54	69.40	76.34	83 28	90.22	97.16	104.10	111.04	117.98	124.92	131.86
55	71.99	79.19	86.39	93.59	100.79	107.99	115.19	122 38	129.58	136.78
56	74.63	82.09	89.56	97.02	104.49	111.95	119.41	126.88	134.34	141.80
57	77.32	85.05	92.78	100.52	108.25	115.98	123.71	131.45	139.17	146.91
58	80.06	88.06	96.07	104.07	112.08	120.09	128.09	136.10	144.10	152.11
59	82.84	91.12	99 41	107.69	115 98	124.26	132.55	140.83	149.12	157.40
60	85.67	94.24	102.81	111.38	119.95	128.51	137.08	145.65	154 22	162.79

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	20	21	22	23	24	25	26	27	28	29
8	3.04	3.19	3.35	3.50	3.65	3.81	3.96	4.11	4.26	4.41
9	3.85	4.04	4.24	4.43	4.62	4.82	5.01	5.20	5.39	5.59
10	4.76	4.99	5.23	5.47	5.71	5.95	6.19	6.42	6.66	6.90
11	5.76	6.05	6.33	6.62	6.91	7.20	7.49	7.77	8.06	8.35
12	6.85	7.19	7.54	7.88	8.22	8.56	8.91	9.25	9.59	9.94
13	8.04	8.44	8.84	9.25	9.65	10.05	10.46	10.86	11.26	11.66
14	9.32	9.79	10.26	10.73	11.19	11.66	12.12	12.59	13.05	13.52
15	10.71	11.24	11.78	12.31	12.85	13.38	13.92	14.45	14.99	15.52
16	12.18	12.79	13.41	14.01	14.62	15.23	15.84	16.45	17.06	17.67
17	13.75	14.44	15.13	15.82	16 51	17.19	17.88	18 57	19.26	19.94
18	15.42	16-19	16.96	17.73	18.51	19.28	20.05	20.82	21.59	22.36
19	17-18	18-04	18.90	19.76	20.62	21.48	22.33	23.19	24.05	24.91
20	19.04	19.99	20.94	21.89	22.84	23.80	24.75	25.70	26.65	27.60
21	20.99	22.04	23.09	24.14	25.19	26.24	27.29	28.34	29.39	30.44
22	23.04	24.19	25.34	26.49	27.65	28.80	29.95	31.10	32.25	33.41
23	25.18	26.43	27.69	28 95	30.21	31.47	32.73	33.99	35.25	36.51
24	27.41	28.78	30.15	31.53	32.90	34.27	35.64	37.01	38.38	39.75
25	29.75	31.23	32.72	34.21	35.70	37.18	38.66	40.16	41.65	43.13
26	32.17	33.78	35.39	37 00	38.61	40.22	41.83	43.44	45.05	46.65
27	34.70	36.43	38.17	39.90	41.64	43.37	45.11	46.84	48.58	50.31
28	37.31	39.18	41.04	42.91	44.78	46.64	48.51	50.37	52.24	54.11
29	40.03	42.03	44.03	46.03	48.03	50.03	52.03	54.04	56.04	58.04
30	42.84	44.98	47.12	49 26	51.41	53 55	55.69	57.83	59.97	62.12
31	45.74	48.02	50.31	52.60	54.89	57.17	59.46	61.75	64.03	66.32
32	48.74	51.17	53.61	56.05	58.49	60.92	63.36	65.79	68.23	70.67
33	51.83	54.42	57.01	59.61	62.20	64.79	67.38	69.97	72.57	75.16
34	55.02	57.77	60.52	63.27	66.03	68.78	71.53	74.28	77.03	79.78
35	58.31	61.22	64.14	67.05	69.97	72.88	75.80	78.71	81.63	84.54
36	61.68	64 77	67.85	70.93	74.02	77.10	80.19	83.27	86.36	89.44
37	65.16	68.41	71.67	74.93	78.19	81.45	84.70	87.96	91 22	94.48
38	68.73	72.16	75 60	79.04	82.47	85.91	89 35	92.78	96 22	99.66
39	72.40	76.02	79.64	83.26	86.88	90.50	94.12	97.74	101.36	104.98
40	76.16	79.97	83.77	87.58	91.39	95.20	99.01	102.81	106.62	110.43
41	80.01	84.01	88.01	92.01	96.01	100 01	104.01	108.01	112.01	116.01
42	83 96	88.16	92.36	96.55	100.75	104.95	109.15	113.35	117.54	121.74
43	88.01	92.41	96.81	101.21	105.61	110.01	114.41	118.81	123.21	127.61
44	92.15	96.75	101.36	105.97	110.58	115.19	119.79	124.40	129.01	133.62
45	96 38	101.20	106.02	110.84	115.66	120.48	125 30	130.12	134.94	139.76
46	100.72	105.75	110.79	115.83	120.86	125.90	130.93	135.97	141.01	146.04
47	105.14	110.40	115.66	120.91	126.17	131.43	136 68	141.94	147.20	152.46
48	109.66	115.14	120.63	126 11	131.59	137.08	142.56	148.04	153 53	159.01
49	114.28	119.99	125.71	131.42	137.14	142.85	148.56	154.28	159.99	165.71
50	119.00	124.95	130.90	136.85	142.80	148.75	154.70	160.65	166.60	172.55
51	123.80	129.99	136.18	142.37	148.56	154.75	160.94	167.13	173.32	179.51
52	128.70	135 14	141.57	148.01	154.44	160.88	167.32	173.75	180.19	186.62
53	133.70	140.38	147.07	153.75	160.44	167.12	173.81	180.49	187.18	193.86
54	138 80	145.74	152.68	159.62	166.56	173.50	180.44	187.38	194.32	201.26
55	143.98	151.18	158.38	165.58	172.78	179.98	187.18	194.38	201.58	208.78
56	149.27	156.73	164.19	171.66	179.12	186 59	194.05	201.51	208.98	216.44
57	154.64	162.38	170.11	177.84	185.57	193.31	201.04	208.77	216.50	224.23
58	160.12	168.12	176.13	184.14	192.14	200.15	208.15	216.16	224.17	232.17
59	165.69	173.97	182.25	190.54	198.82	207.11	215.39	223.68	231.96	240.25
60	171.35	179.92	188.49	197.06	205.62	214.19	222.76	231.33	239.90	248.46

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	30	31	32	33	34	35	36	37	38	39
8	4.57	4.72	4.87	5.02	5.17	5.33	5.48	5.63	5.78	5.94
9	5.78	5.97	6.17	6.36	6.55	6.74	6.94	7.13	7.32	7.51
10	7.14	7.37	7.61	7.85	8.09	8.33	8.56	8.80	9.04	9.28
11	8.64	8.93	9.21	9.50	9.79	10.08	10.36	10.65	10.94	11.23
12	10.28	10.62	10.96	11.31	11.65	11.99	12 34	12.68	13.02	13.36
13	12.06	12.46	12.87	13.27	13.67	14.07	14.47	14.88	15.28	15.68
14	13.99	14.46	14.92	15.39	15.86	16.32	16.79	17.26	17.72	18.18
15	16.06	16.60	17.13	17 67	18.20	18.74	19.27	19.81	20.34	20.88
16	18.28	18.89	19.50	20.11	20.72	21.33	21.93	22.54	23.15	23.76
17	20 63	21.32	22 01	22.69	23.38	24.07	24.76	25.44	26.13	26.82
18	23.13	23.90	24 67	25.44	26-22	26.99	27.76	28.53	29 30	30.07
19	25.77	26.63	27.49	28.35	29.21	30.06	30.92	31.78	32.64	33.50
20	28.56	29 51	30.46	31.41	32.36	33.32	34.27	35 22	36.17	37.12
21	31.49	32.52	33.58	34.63	35.68	36 73	37.78	38.83	39.88	40.93
22	34.56	35.71	36.86	38.01	39.16	40.32	41.47	42.62	43.77	44.92
23	37.77	39.02	40.28	41.54	42.80	44.06	45.32	46.58	47.84	49.10
24	41.12	42.49	43.86	45.23	46.60	47.98	49.35	50.72	52.09	53.46
25	44.62	46.11	47.60	49 08	50.57	52.06	53.55	55.03	56.52	58.01
26	48.26	49.87	51.48	53.09	54.70	56.31	57.92	59.52	61.13	62.74
27	52.05	53.78	55.52	57.25	58.99	60.72	62.46	64.19	65.93	67.66
28	55.97	57.84	59.70	61.57	63.43	65.30	67.17	69.03	70 90	72.77
29	60.04	62.04	64.04	66.04	68.05	70.05	72 05	74.05	76 05	78.05
30	64.26	66.40	68 54	70.68	72.83	74.97	77.11	79.25	81.39	83 53
31	68.61	70.89	73.18	75.47	77.75	80.04	82.33	84.62	86.90	89.19
32	73.11	75.54	77.98	80.42	82.85	85.29	87.73	90.17	92.61	95.04
33	77.75	80.34	82 93	85.52	88.12	90.71	93 30	95.89	98.48	101.07
34	82.53	85.29	88.04	90 79	93.54	96.29	99.04	101.79	104.54	107.30
35	87.46	90.38	93.29	96.21	99.12	102.04	104.95	107.87	110.78	113.70
36	92.52	95.61	98.69	101.78	104.86	107.95	111.03	114.11	117.20	120.28
37	97.74	100.99	104.25	107.51	110.77	114.03	117.28	120.54	123.80	127.06
38	103.09	106 53	109.97	113.40	116.84	120.28	123.71	127.15	130.59	134.02
39	108.60	112.22	115.84	119 46	123.08	126.70	130.32	133.94	137.56	141.18
40	114.24	118.04	121.85	125.66	129.47	133.28	137.08	140.89	144.77	148.51
41	120.01	124.01	128.01	132 01	136.02	140.02	144.02	148.02	152.02	156.02
42	125.94	130.14	134.34	138.54	142.73	146.93	151.13	155.33	159.53	163.72
43	132.01	136.41	140.81	145.21	149.62	154.02	158.42	162.82	167.22	171.62
44	138.22	142.83	147.44	152 05	156.65	161.26	165.87	170.48	175.08	179.69
45	144.58	149.40	154.21	159.03	163.85	168.67	173.49	178.31	183.13	187.95
46	151.08	156.11	161.15	166.19	171 22	176.26	181.29	186.33	191.37	196.40
47	157.71	162.97	168.23	173 49	178.74	184.00	189.26	194.52	199.77	205.03
48	164.49	169 98	175.46	180.94	186.43	191.91	197.39	202.88	208 36	213.84
49	171.42	177.14	182.85	188.56	194 28	199.99	205.71	211.42	217.13	222.85
50	178.50	184.45	190.40	196.35	202.30	208.25	214.20	220.15	226.10	232.05
51	185.70	191 89	198.08	204 27	210.47	216.66	222.85	229.04	235.23	241.42
52	193.06	199.49	205.93	212.36	218.80	225.23	231.67	238.10	244.54	250.98
53	200.55	207.23	213.92	220.60	227 29	233 97	240.66	247.34	254.03	260.71
54	208.20	215.14	222.08	229.02	235.96	242.90	249.84	256.78	263.72	270.66
55	215.98	223.18	230.38	237.58	244.77	251.97	259.17	266.37	273.57	280.77
56	223.90	231.37	238.83	246.29	253.76	261.22	268.68	276 15	283.61	291.08
57	231.97	239.70	247.43	255.16	262.90	270.63	278.36	286.09	293.83	301.56
58	240.18	248.18	256.19	264.20	272.20	280.21	288.21	296.22	304.23	312.23
59	248.53	256.81	265.10	273.38	281.67	289.95	298.24	306.52	314.81	323.09
60	257.03	265.60	274.17	282.74	291.30	299.87	308.44	317.01	325.58	334.14

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	40	41	42	43	44	45	46	47	48	49
8	6.09	6.24	6.39	6.54	6.70	6.85	7.01	7.16	7.31	7.46
9	7.71	7.90	8.09	8.28	8.48	8.67	8.86	9.05	9.25	9.44
10	9.52	9.75	9.99	10.23	10.47	10.71	10.94	11.18	11.42	11.66
11	11.52	11.81	12.09	12.38	12.67	12.96	13.24	13.53	13.82	14.11
12	13.71	14.05	14.39	14.73	15.07	15.42	15.76	16.10	16.45	16.79
13	16.08	16.49	16.89	17.29	17.69	18.09	18.50	18.90	19.31	19.71
14	18.65	19.12	19.58	20.05	20.52	20.98	21.45	21.92	22.38	22.85
15	21.42	21.95	22.49	23.02	23.56	24.09	24.63	25.16	25.70	26.23
16	24.37	24.98	25.59	26.21	26.81	27.42	28.03	28.64	29.25	29.86
17	27.51	28.19	28.88	29.57	30.26	30.95	31.64	32.32	33.01	33.70
18	30.84	31.61	32.38	33.15	33.93	34.69	35.47	36.24	37.01	37.78
19	34.36	35.22	36.08	36.94	37.80	38.66	39.51	40.37	41.23	42.09
20	38.08	39.03	39.98	40.93	41.88	42.84	43.78	44.74	45.69	46.64
21	41.98	43.03	44.08	45.13	46.18	47.23	48.28	49.33	50.38	51.43
22	46.08	47.23	48.38	49.53	50.68	51.84	52.99	54.14	55.29	56.44
23	50.36	51.61	52.87	54.13	55.39	56.65	57.91	59.17	60.43	61.69
24	54.83	56.20	57.57	58.94	60.31	61.68	63.06	64.43	65.80	67.17
25	59.50	60.98	62.47	63.96	65.45	66.93	68.42	69.91	71.40	72.88
26	64.35	65.96	67.57	69.18	70.79	72.40	74.00	75.61	77.22	78.83
27	69.40	71.13	72.87	74.60	76.34	78.07	79.81	81.54	83.28	85.01
28	74.63	76.50	78.36	80.23	82.09	83.96	85.83	87.69	89.56	91.42
29	80.06	82.06	84.06	86.06	88.06	90.06	92.06	94.07	96.07	98.07
30	85.68	87.82	89.96	92.10	94.24	96.40	98.53	100.67	102.81	104.95
31	91.48	93.76	96.05	98.34	100.62	102.91	105.20	107.49	109.77	112.06
32	97.48	99.91	102.35	104.79	107.22	109.66	112.10	114.54	116.97	119.41
33	103.66	106.26	108.85	111.44	114.03	116.63	119.22	121.80	124.40	126.99
34	110.05	112.80	115.55	118.30	121.05	123.80	126.55	129.31	132.06	134.81
35	116.62	119.53	122.45	125.36	128.28	131.19	134.11	137.02	139.91	142.85
36	123.37	126.45	129.54	132.62	135.70	138.79	141.87	144.96	148.04	151.13
37	130.32	133.57	136.83	140.09	143.35	146.61	149.86	153.12	156.38	159.64
38	137.46	140.93	144.33	147.77	151.21	154.64	158.08	161.52	164.95	168.39
39	144.80	148.42	152.04	155.66	159.28	162.90	166.52	170.14	173.76	177.38
40	152.32	156.12	159.93	163.74	167.55	171.36	175.16	178.97	182.78	186.59
41	160.02	164.02	168.02	172.02	176.02	180.02	184.02	188.02	192.02	196.02
42	167.92	172.12	176.32	180.52	184.72	188.91	193.11	197.31	201.51	205.71
43	176.02	180.42	184.82	189.22	193.62	198.02	202.42	206.82	211.22	215.62
44	184.30	188.91	193.51	198.12	202.73	207.34	211.94	216.55	221.16	225.77
45	192.77	197.59	202.41	207.23	212.05	216.87	221.69	226.51	231.33	236.14
46	201.44	206.48	211.51	216.55	221.58	226.62	231.66	236.69	241.73	246.76
47	210.29	215.54	220.80	226.06	231.32	236.57	241.83	247.09	252.35	257.60
48	219.33	224.81	230.29	235.78	241.26	246.74	252.23	257.71	263.19	268.68
49	228.56	234.28	239.99	245.71	251.42	257.13	262.85	268.56	274.28	279.99
50	238.00	243.95	249.90	255.85	261.80	267.75	273.70	279.65	285.60	291.55
51	247.61	253.80	259.99	266.18	272.37	278.56	284.75	290.94	297.13	303.33
52	257.41	263.85	270.28	276.72	283.15	289.59	296.02	302.46	308.89	315.33
53	267.40	274.08	280.77	287.45	294.14	300.82	307.51	314.19	320.88	327.56
54	277.60	284.54	291.48	298.42	305.36	312.30	319.24	326.18	333.12	340.06
55	287.97	295.17	302.37	309.57	316.77	323.97	331.17	338.37	345.57	352.77
56	298.54	306.00	313.47	320.93	328.39	335.86	343.32	350.78	358.25	365.71
57	309.29	317.02	324.76	332.49	340.22	347.95	355.69	363.42	371.15	378.88
58	320.24	328.25	336.25	344.26	352.26	360.27	368.28	376.28	384.29	392.29
59	331.38	339.66	347.94	356.23	364.51	372.80	381.08	389.37	397.65	405.94
60	342.71	351.28	359.85	368.41	376.98	385.55	394.12	402.69	411.25	419.82

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	50	51	52	53	54	55	56	57	58	59
8	7.61	7.76	7.92	8.07	8.22	8.37	8.52	8.68	8.83	8.98
9	9.63	9.83	10.02	10.21	10.41	10.59	10.79	10.98	11.17	11.37
10	11.90	12.14	12.37	12.61	12.85	13.09	13.33	13.56	13.80	14.04
11	14.41	14.69	14.97	15.26	15.55	15.84	16.12	16.41	16.71	16.99
12	17.13	17.47	17.82	18.16	18.51	18.84	19.19	19.54	19.87	20.22
13	20.11	20.51	20.91	21.31	21.72	22.12	22.52	22.92	23.32	23.73
14	23.32	23.78	24.25	24 71	25.18	25.65	26.11	26.58	27 05	27.51
15	26.77	27.31	27.84	28.38	28.91	29.45	29.98	30.52	31.05	31.59
16	30.47	31.08	31.69	32.29	32.91	33.51	34.12	34.73	35.34	35.95
17	34.39	35.07	35.76	36.45	37.14	37.83	38.51	39.21	39.89	40.58
18	38.55	39.32	40.09	40.86	41.63	42.41	43.18	43.95	44.72	45.49
19	42.95	43.81	44.67	45.53	46.39	47.25	48.11	48.96	49.83	50.68
20	47.60	48.55	49.50	50.45	51.40	52.36	53 31	54.26	55.21	56.16
21	52.48	53.53	54.58	55.63	56.68	57.73	58.78	59.83	60.87	61.92
22	57.60	58.75	59.91	61.05	62.21	63.36	64.51	65.66	66.81	67.96
23	62.95	64.20	65.46	66.72	67.98	69.24	70.50	71.76	73.02	74.28
24	68.54	69.91	71.28	72.65	74.02	75.39	76.76	78.13	79.51	80.88
25	74.37	75.86	77.35	78.83	80.32	81.81	83.30	84.78	86.27	87.76
26	80.44	82.05	83.66	85.27	86.88	88.48	90.09	91.70	93.31	94.92
27	86.75	88.48	90.22	91.95	93.69	95.42	97.16	98.89	100.63	102.36
28	93.29	95.16	97.02	98.89	100.75	102.62	104.49	106.35	108.22	110 08
29	100.07	102.07	104.07	106.07	108.07	110.08	112.08	114.08	116.08	118.08
30	107.10	109.24	111.38	113.52	115.66	117.81	119.95	122 09	124.23	126.38
31	114.35	116.63	118.92	121.21	123.49	125.78	128.07	130.36	132.64	134.94
32	121.85	124.28	126.72	129.16	131.59	134.03	136.47	138.91	141.34	143.78
33	129.59	132.18	134.77	137.36	139.95	142.54	145.14	147.73	150.32	152.91
34	137.56	140.31	143.06	145.81	148.57	151.32	154.07	156.82	159.57	162.32
35	145.77	148.69	151.60	154.52	157.43	160.35	163 26	166.18	169.09	172.01
36	154.21	157.29	160 38	163.46	166.55	169.63	172.72	175.80	178.88	181.97
37	162.90	166.15	169 41	172.67	175.93	179.19	182.44	185.70	188.96	192.22
38	171.83	175.26	178 70	182.13	185.57	189.01	192.44	195.88	199.32	202.75
39	181.00	184.62	188.24	191.86	195.48	199.10	202.72	206.34	209.96	213.58
40	190.40	194.21	198.02	201.82	205.63	209.44	213.24	217.06	220.86	224.67
41	200.03	204.03	208.03	212 03	216.03	220.03	224.03	228.03	232 03	236.03
42	209.91	214.10	218.30	222.50	226.70	230.90	235.09	239.29	243.49	247.69
43	220 03	224.43	228.83	233.23	237.63	242.03	246.43	250.83	255.23	259.63
44	230.38	234.98	239.59	244.20	248.81	253.41	258.02	262.63	267.24	271.84
45	240.96	245.78	250 60	255.42	260.24	265.06	269.88	274.70	279.52	284.34
46	251 80	256.84	261.87	266 91	271.94	276.98	282.02	287.05	292.09	297.12
47	262 86	268.12	273.37	278.63	283 89	289.15	294.40	299.66	304.92	310.18
48	274.16	279.64	285.13	290 61	296.09	301.58	307.06	312.54	318.03	323.51
49	285.71	291.42	297.13	302.85	308.56	314 28	319 99	325.70	331.42	337.13
50	297.50	303.45	309.40	315 35	321.30	327.25	333.20	339.15	345.10	351.05
51	309.51	315.70	321.89	328.08	334.27	340.46	346.65	352.84	359.03	365.22
52	321.77	328.20	334.64	341.07	347.51	353.94	360.38	366.81	373.25	379.68
53	334.25	340.94	347.62	354 31	360.99	367.68	374 36	381.05	387.73	394.42
54	347.00	353.94	360.88	367.82	374.76	381.70	388.64	395.58	402.52	409.46
55	359.97	367.16	374.36	381.56	388.76	395.96	403.16	410.36	417.56	424.76
56	373.18	380.64	388.10	395.57	403.03	410.49	417.96	425.42	432.88	440.37
57	386.62	394.35	402.08	409 81	417.54	425.28	433.01	440.74	448.47	456.21
58	400.30	408.31	416.31	424.32	432.32	440.33	448.34	456.34	464.35	472 35
59	414.22	422.50	430.79	439.07	447 36	455.64	463.93	472.21	480.50	488.78
60	428.39	436.96	445.53	454.09	462.66	471.23	479.80	488.37	496.93	505.50

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	60	61	62	63	64	65	66	67	68	69
8	9.13	9.29	9.44	9.59	9.74	9.89	10.05	10.21	10.36	10.51
9	11.56	11.75	11.94	12.14	12.33	12.53	12.72	12.91	13.10	13.29
10	14.28	14.52	14.75	14.99	15.23	15 47	15.71	15.94	16.18	16.42
11	17.28	17.56	17.85	18.14	18.43	18.72	19.01	19.29	19.58	19.87
12	20.56	20.91	21.24	21.59	21.93	22.27	22.62	22.96	23.30	23.64
13	24.13	24.53	24.94	25.34	25.74	26.14	26.54	26.94	27.35	27.75
14	27.98	28.45	28.91	29.38	29.84	30.31	30.78	31.24	31.71	32,18
15	32.13	32.66	33.20	33.73	34.27	34.80	35.34	35.87	36.41	36.94
16	36.56	37.17	37.78	38.39	39.00	39.61	40.22	40 83	41.44	42.05
17	41.26	41.95	42.64	43.33	44.02	44.71	45.39	46.08	46.77	47.46
18	46.26	47.01	47.81	48.58	49.35	50.12	50 89	51.66	52.43	53.21
19	51.54	52.41	53.26	54.12	54.98	55.84	56.70	57.56	58.42	59.28
20	57.12	58.07	59 02	59.97	60.92	61.88	62.83	63.78	64.73	65.68
21	62.97	64.02	65.07	66.12	67.17	68.22	69.27	70.32	71.37	72.42
22	69.12	70.27	71.42	72.57	73.73	74.88	76.03	77.18	78.33	79.48
23	75.54	76.79	78.05	79.31	80.57	81.83	83.09	84.35	85.61	86.87
24	82.25	83.62	84.99	86 36	87.73	89.10	90.47	91.84	93.21	94.59
25	89.25	90.73	92.22	93.71	95.20	96.68	98.17	99.66	101.15	102.63
26	96,53	98.14	99.75	101.36	102.96	104.57	106.18	107.79	109.40	111.01
27	104.10	105.84	107.57	109.31	111.04	112.77	114.51	116.24	117.98	119.72
28	111.95	113.81	115 68	117.55	119 41	121.28	123.14	125.01	126.88	128.74
29	120.09	122.09	124.09	126.09	128.09	130.09	132.09	134.10	136.10	138.10
30	128.52	130.66	132 80	134.94	137.08	139.23	141.37	143 51	145.65	147.79
31	137,22	139.51	141.79	144.08	146 36	148.65	150.94	153 22	155.51	157.80
32	146.22	148.65	151.09	153.53	155.96	158.41	160.84	163.28	165.72	168.15
33	155.50	158.09	160.69	163.28	165.87	168.46	171.05	173.65	176.24	178.83
34	165.08	167.82	170.58	173.33	176.08	178.83	181.58	184.33	187.08	189 83
35	174.93	177.84	180.76	183.67	186.59	189.50	192.42	195.33	198.25	201.16
36	185.05	188.14	191.22	194.31	197.39	200.47	203.56	206.64	209.73	212.81
37	195.48	198.73	201.99	205.25	208.51	211.77	215.02	218.28	221.54	224.80
38	206.19	209.63	213.06	216.50	219.94	223.37	226.81	230.25	233.68	237.12
39	217.20	220.82	224.44	228.06	231.68	235.30	238.92	242.54	246.16	249.78
40	228.48	232.29	236.09	239.91	243.71	247.52	251.32	255.13	258.94	262.75
41	240 03	244.03	248.03	252.03	256.03	260.03	264.03	268.04	272.04	276.04
42	251.89	256.09	260.28	264.48	268.68	272.88	277.08	281.27	285.47	289.67
43	264.03	268.43	272.83	277.23	281.63	286.03	290.43	294.84	299.24	303.64
44	276.45	281.06	285.67	290.27	294.88	299.49	304.10	308.70	313.31	317.92
45	289.16	293.98	298.80	303.62	308.44	313.26	318.08	322 89	327.71	332.53
46	302.16	307.20	312 23	317.27	322.31	327.34	332.38	337.41	342 45	347.49
47	315.43	320.69	325 95	331.20	336.46	341.72	346.98	352.23	357.48	362.75
48	328.99	334.48	339.96	345.44	350.93	356.41	361.89	367 38	372.86	378.34
49	342.85	348.56	354.28	359.99	365.70	371.42	377.13	382.85	388.56	394.27
50	357.00	362.95	368.90	374.85	380.80	386.75	392.70	398.65	404.60	410.55
51	371.41	377.60	383.79	389.98	396.17	402.36	408.55	414.75	420.94	427.13
52	386.12	392.55	398.99	405.43	411.86	418.30	424.73	431.17	437.60	444.04
53	401.10	407.79	414.47	421.16	427.84	434.53	441.21	447.90	454.58	461.27
54	416.40	423.34	430.28	437.22	444.16	451.10	458.04	464.98	471.92	478.86
55	431.96	439.16	446.36	453.56	460.76	467.96	475.16	482.35	489.55	496.75
56	447.81	455.27	462.74	470.20	477.67	485.13	492.59	500.06	507.52	514.98
57	463.94	471.67	479.40	487.14	494.87	502.60	510.33	518.07	525 80	533.53
58	480.36	488.37	496.37	504.38	512.39	520.39	528.40	536.40	544.41	552.42
59	497.07	505.35	513.63	521.92	530.20	538.49	546.77	555 06	563.34	571.63
60	514.07	522 64	531.20	539.77	548.34	556.91	565.48	574.04	582.61	591.18

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	70	71	72	73	74	75	76	77	78	79
8	10.66	10.81	10.96	11.12	11.27	11.42	11.57	11.72	11.88	12.03
9	13.49	13.68	13.87	14.06	14.26	14.45	14.64	14.84	15.03	15.22
10	16.66	16.89	17.13	17.37	17.61	17.85	18.08	18.32	18.56	18.80
11	20.16	20.45	20.73	21.02	21.31	21.60	21.88	22.17	22.46	22.75
12	23.99	24.33	24.67	25.01	25.36	25.70	26.04	26.38	26.73	27.07
13	28.15	28.55	28.95	29.36	29.76	30.16	30.56	30.96	31.37	31.77
14	32.64	33.11	33.58	34.04	34.51	34.98	35.44	35.91	36.37	36.84
15	37.48	38.02	38.55	39.09	39.62	40.16	40.69	41.23	41.76	42.30
16	42.66	43.26	43.87	44.48	45.09	45.71	46.31	46.92	47.53	48.14
17	48.14	48.83	49.52	50.21	50.89	51.58	52.27	52.96	53.64	54.33
18	53.98	54.74	55.51	56.29	57.06	57.83	58.60	59.37	60.14	60.91
19	60.13	60.98	61.85	62.71	63.57	64.43	65.29	66.15	67.01	67.86
20	66.64	67.59	68.54	69.49	70.44	71.40	72.35	73.30	74.25	75.20
21	73.46	74.52	75.57	76.62	77.67	78.72	79.76	80.81	81.86	82.91
22	80.64	81.79	82.94	84.09	85.24	86.40	87.55	88.70	89.85	91.01
23	88.13	89.38	90.64	91.90	93.16	94.42	95.68	96.94	98.20	99.46
24	95.96	97.33	98.70	100.07	101.44	102.81	104.18	105.55	106.92	108.29
25	104.12	105.61	107.10	108.58	110.07	111.56	113.05	114.53	116.02	117.51
26	112.62	114.23	115.84	117.44	119.05	120.66	122.27	123.88	125.49	127.10
27	121.45	123.18	124.92	126.65	128.39	130.12	131.86	133.59	135.33	137.06
28	130.61	132.47	134.34	136.21	138.07	139.94	141.80	143.67	145.54	147.40
29	140.10	142.10	144.10	146.10	148.10	150.11	152.11	154.11	156.11	158.11
30	149.94	152.08	154.22	156.36	158.51	160.65	162.79	164.93	167 07	169.21
31	160.09	162.37	164.66	166.95	169.23	171.52	173.81	176.09	178.38	180.67
32	170.59	173.02	175.46	177.90	180.33	182.77	185.21	187.64	190.08	192.52
33	181.42	184.01	186.60	189 20	191.79	194.38	196.97	199.56	202.16	204.75
34	192.59	195.34	198.09	200.84	203.59	206.34	209.09	211.85	214.60	217.35
35	204.08	207.00	209.91	212.83	215.74	218.66	221.57	224.49	227.40	230.32
36	215.90	218.98	222.06	225.15	228.23	231.31	234.40	237.49	240.57	243.65
37	228.06	231.31	234.57	237.83	241.09	244.35	247.60	250.86	254.12	257.38
38	240.56	243.99	247.43	250.87	254.30	257.74	261.18	264.61	268.05	271.49
39	253.40	257.02	260.64	264.26	267.88	271.50	275.12	278.74	282.36	285.98
40	266.56	270.37	274.18	277.99	281.79	285.60	289.41	293.21	297.02	300.83
41	280.04	284.04	288.01	292.04	296.04	300.04	304.04	308.04	312.04	316.04
42	293.87	298.07	302 27	306.46	310.66	314.86	319.06	323.26	327.45	331.65
43	308.04	312.44	316.84	321.24	325.64	330.04	334.44	338.84	343.24	347.64
44	322.53	327.13	331.74	336.35	340.96	345.57	350.17	354.78	359.39	364.00
45	337.35	342.17	346.99	351 81	356 63	361.45	366 27	371.09	375.91	380.73
46	352.52	357.56	362 59	367.63	372.67	377.70	382.74	387.77	392.81	397.85
47	368 01	373.26	378.52	383.78	389.04	394.29	399.55	404.81	410.06	415.32
48	383.83	389.31	394.79	400.28	405.76	411.24	416.73	422.21	427.69	433.18
49	399.99	405 70	411.42	417.13	422.85	428 56	434.27	439.99	445.70	451.42
50	416.50	422 45	428 40	434.35	440.30	446.25	452.20	458.15	464.10	470.05
51	433.32	439.51	445.70	451.89	458.08	464.27	470.46	476.65	482.84	489.03
52	450.47	456.91	463.34	469.78	476.21	482.65	489.09	495.52	501 96	508.39
53	467.95	474.64	481.32	488.01	494.69	501.38	508.06	514.75	521.43	528.12
54	485.80	492.74	499.68	506.62	513.56	520.50	527.44	534.38	541.32	548.26
55	503.95	511.15	518.35	525.55	532.75	539.95	547.15	554.35	561.55	568.75
56	522.45	529.91	537.37	544.84	552 30	559.77	567.23	574.69	582.16	589.62
57	541.26	549.00	556.73	564.46	572.19	579.93	587.66	595.39	603.12	610.85
58	560.42	568.43	576.43	584.44	592.45	600.45	608.46	616.46	624.47	632.48
59	579.91	588.19	596.48	604.76	613 05	621.33	629.62	637.90	646.19	654.47
60	599.75	608.32	616.88	625.45	634.02	642.59	651.16	659.72	668.29	676.86

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	80	81	82	83	84	85	86	87	88	89
8	12.18	12.33	12.49	12.64	12.79	12.94	13.09	13.25	13.40	13.55
9	15.41	15.61	15.80	15.99	16.18	16.37	16.57	16.76	16.95	17.15
10	19.04	19.27	19.51	19.75	19.99	20.23	20.46	20.70	20.94	21.18
11	23.04	23.32	23.61	23.90	24.19	24.48	24.76	25.05	25.34	25.63
12	27.41	27.75	28.10	28.44	28.78	29.12	29.47	29.81	30.15	30.50
13	32.17	32.57	32.98	33.38	33.78	34.18	34.58	34.99	35.39	35.79
14	37.31	37.77	38.24	38.71	39.17	39.64	40.11	40.57	41.04	41.50
15	42.84	43.37	43.91	44.44	44.98	45.51	46.05	46.58	47.12	47.65
16	48.75	49.36	49.97	50.58	51.18	51.79	52.41	53.01	53.62	54.23
17	55.02	55.71	56.39	57.08	57.77	58.46	59.15	59.83	60.52	61.21
18	61.68	62.45	63.23	64.00	64.77	65.54	66.31	67.08	67.85	68.62
19	68.72	69.58	70.44	71.31	72.16	73.02	73.88	74.74	75.60	76.46
20	76.16	77 11	78.06	79.01	79.96	80.92	81.87	82.82	83.77	84.72
21	83.98	85.01	86.06	87.11	88.16	89.21	90.26	91.31	92.36	93.41
22	92.16	93.31	94 46	95.61	96.76	97.92	99.07	100.22	101.37	102.52
23	100 72	101.97	103.23	104.49	105.75	107.01	108.27	109.53	110.79	112 05
24	109.66	111.04	112.41	113.78	115.15	116.52	117.89	119.26	120.63	122.00
25	119.00	120.48	121 97	123.46	124.95	126.43	127.92	129.41	130.90	132.38
26	128.71	130.32	131.92	133.53	135.14	136.75	138.36	139 97	141.58	143.19
27	138.80	140.53	142.27	144.00	145.74	147.47	149.21	150.94	152.68	154.41
28	149.27	151.13	153.00	154.86	156.73	158.60	160.46	162.33	164.19	166.06
29	160.12	162.12	164.12	166.12	168.12	170.12	172.12	174.13	176.13	178.13
30	171.36	173.50	175 64	177.78	179.92	182.07	184.21	186.35	188.49	190.63
31	182.96	185.24	187.53	189.82	192.10	194.39	196.68	198.96	201.25	203.54
32	194.96	197.39	199.83	202.27	204.71	207.14	209 58	212.01	214.45	216.89
33	207.34	209.93	212.52	215.11	217.71	220.30	222.89	225.48	228.07	230.67
34	220.10	222.85	225.60	228.35	231.10	233.86	236.61	239.36	242.11	244.86
35	233.24	236 15	239.05	241.98	244.90	247.81	250.73	253.64	256.56	259.47
36	246.74	249.82	252.91	255.99	259.08	262.16	265.24	268.33	271.41	274 50
37	260.64	263.89	267.15	270.41	273.67	276.93	280.18	283.44	286.70	289.96
38	274.92	278.36	281.80	285.23	288.67	292.11	295 54	298.98	302.42	305.85
39	289.60	293.22	296.84	300.46	304.08	307.70	311.32	314.94	318.56	322.18
40	304.64	308.44	312.25	316 06	319.87	323.68	327.48	331.29	335.10	338.91
41	320.04	324 04	328.04	332.04	336.05	340.05	344.05	348.05	352.05	356.05
42	335.85	340.05	344.25	348.45	352.64	356.84	361.04	365.24	369.44	373.63
43	352.04	356 44	360.84	365.24	369.65	374.05	378.45	382.85	387.25	391.65
44	368.60	373.21	377.82	382.43	387.03	391.64	396.25	400.86	405.46	410.07
45	385.55	390.37	395.19	400.01	404.82	409.64	414.46	419 28	424.10	428.92
46	402.88	407.92	412.96	417.99	423.03	428.06	433.10	438.14	443.17	448.21
47	420.58	425.84	431.09	436.35	441.61	446.87	452.12	457.38	462.64	467.89
48	438.66	444.14	449.63	455.11	460.59	466.08	471.56	477.04	482.53	488.01
49	457.13	462.85	468.56	474.27	479.99	485.70	491.42	497.13	502.84	508.56
50	476.00	481.95	487.90	493.85	499 80	505.75	511.70	517.65	523.60	529.55
51	495.22	501.41	507.60	513.79	519 98	526.17	532.36	538.55	544.74	550.93
52	514.83	521.26	527.70	534.13	540.57	547.00	553.44	559.87	566.31	572.75
53	534.80	541.49	548.17	554.86	561.54	568.23	574.91	581.60	588.28	594.97
54	555.29	562.14	569.08	576.02	582.96	589.90	596.84	603.78	610.72	617.66
55	575.95	583.15	590.35	597.55	604.74	611.94	619.14	626.34	633.54	640.74
56	597.08	604.55	612.01	619.47	626.94	634.40	641.86	649.33	656.79	664.26
57	618.59	626.32	634.05	641.78	649.52	657.25	664.98	672.71	680.45	688.18
58	640 48	648.49	656 50	664.50	672.51	680.51	688.52	696.53	704.53	712.54
59	662.72	771 04	679.32	687.61	695.89	704.18	712.46	720.75	729.03	737.32
60	685.43	693 99	702.56	711.13	719.70	728.27	736.83	745.40	753.97	762.54

No. 6.—*Continued.*

Diameter.	PRESSURE.									
	90	91	92	93	94	95	96	97	98	99
8	13.71	13.86	14.01	14.16	14.31	14.46	14.62	14.77	14.92	15.07
9	17.34	17.53	17.72	17.92	18.11	18.31	18.49	18.69	18.88	19.07
10	21.42	21.65	21.89	22.13	22.37	22.61	22.84	23.08	23.32	23.56
11	25 92	26.20	26.49	26.78	27.07	27.36	27.64	27.93	28.22	28.51
12	30.84	31.18	31.52	31.87	32.21	32.55	32.89	33.24	33.58	33.92
13	36.19	36.60	37.00	37.41	37.81	38.21	38.61	39.01	39.41	39.81
14	41.97	42.44	42.90	43.37	43.84	44.30	44.77	45 24	45.70	46.17
15	48.19	48.73	49.26	49.80	50 33	50.87	51.40	51.94	52.47	53.01
16	54 84	55.45	56.06	56.67	57 28	57.89	58.50	59.11	59.72	60.33
17	61.90	62.58	63 27	63.96	64.65	65.34	66.02	66.71	67.40	68.09
18	69.39	70.17	70 94	71.71	72 48	73.25	74.02	74.79	75.56	76.33
19	77.31	78.17	79.03	79.89	80.75	81.61	82.47	83.33	84.19	85.05
20	85.68	86.63	87.58	88.53	89.48	90.44	91.39	92.34	93 29	94.24
21	94.46	95.51	96.56	97.61	98.66	99.71	100.76	101.81	102.86	103.91
22	103.68	104.83	105.98	107.13	108.28	109.44	110.59	111.74	112.89	114 04
23	113.31	114.56	115.82	117.08	118.34	119.60	120.86	122.12	123 38	124.64
24	123.37	124.74	126.12	127 49	128.86	130.23	131.60	132.97	134.34	135.71
25	133.87	135,36	136.85	138.33	139.82	141.31	142.80	144.28	145.77	147.26
26	144.80	146.40	148.01	149.62	151.23	152.84	154.45	156.06	157.67	159.28
27	156.15	157.88	159.62	161.35	163.09	164.82	166.56	168.29	170 03	171.76
28	167.93	169.79	171.66	173 52	175.39	177.26	179.12	180.99	182 85	184.72
29	180.13	182 13	184.13	186.13	188 14	190 14	192.14	194.14	196.14	198.14
30	192.78	194.92	197.06	199.21	201.34	203.49	205.63	207.77	209.91	212.05
31	205.83	208.11	210.40	212.69	214.97	217.26	219.55	221.84	224.12	226.41
32	219.33	221.76	224.20	226.64	229.07	231.51	233.95	236.38	238.82	241.26
33	233.26	235 85	238.44	241.03	243.62	246.22	248.81	251.40	253.99	256.58
34	247.61	250 36	253.11	255.87	258.62	261.37	264.12	266.87	269.62	272.37
35	262.39	265.31	268.22	271.14	274.05	276.97	279.88	282.80	285.71	288.63
36	277.58	280.67	283.75	286.83	289.92	293.00	296.09	299.17	302.26	305.34
37	293.22	296.47	299.73	302.99	306 25	309.51	312.76	316.02	319.28	322.54
38	309.29	312.73	316.16	319.60	323.04	326.47	329.91	333.35	336.78	340.22
39	325.80	329.42	333.04	336.66	340.28	343.90	347.52	351.14	354.76	358.38
40	342.72	346.52	350.33	354.14	357.94	361.76	365.56	369.37	373.18	376.99
41	360.05	364.05	368.05	372.05	376.05	380.05	384.05	388.05	392.05	396.05
42	377.83	382.03	386.23	390.43	394.63	398.82	403 02	407.22	411.42	415.62
43	396 05	400.45	404.85	409.25	413.65	418.05	422.45	426.85	431 25	435.65
44	414.68	419.29	423.89	428.50	433.11	437.72	442.32	446.93	451.54	456.15
45	433.74	438.56	443.38	448.20	453.02	457.84	462.66	467.48	472.30	477.12
46	453.24	458.28	463.32	468.35	473.39	478.42	483.46	488.50	493.53	498.57
47	473.15	478.41	483.67	488.92	494.18	499.44	504.70	509.95	515.21	520 47
48	493.49	498.98	504.46	509.94	515.43	520.91	526.39	531.88	537.36	542.84
49	514.27	519.99	525.70	531.42	537.13	542.84	548.56	554.27	559.99	565.70
50	535.50	541.45	547.40	553.35	559.30	565.25	571.20	577.15	583.10	589.05
51	557.12	563 31	569.50	575.69	581.88	588.07	594.26	600.45	606.64	612.83
52	579.18	585.62	592.05	598.49	604.92	611.36	617.79	624.23	630.66	637.10
53	601.65	608 34	615.02	621.71	628.39	635.08	641.76	648.45	655.13	661.82
54	624.60	631.54	638.48	645 42	652 36	659.30	666.24	673.18	680.12	687.06
55	647.94	655.14	662.34	669.54	676.74	683.94	691.14	698.34	705.54	712.74
56	671.72	679.18	686.65	694.11	701.57	709.04	716.50	723.96	731.43	738.89
57	695.91	703.64	711.38	719.11	726.84	734.57	742.31	750.04	757.77	765.50
58	720.54	728.55	736.56	744.56	752.57	760.57	768.58	776.59	784.59	792.60
59	745 60	753.88	762.17	770.45	778.74	787.02	795.31	803.59	811.88	820.16
60	771.11	779.67	788.24	796.81	805.38	813.95	822.51	831.08	839.65	848.22

No. 5.—*Continued.*

Diameter.	PRESSURE.										
	100	101	102	103	104	105	106	107	108	109	110
8	15.23	15.38	15.53	15.68	15.84	15.99	16.14	16.29	16.44	16.60	16.75
9	19.27	19.46	19.65	19.84	20.04	20.23	20.42	20.61	20.81	21.00	21.19
10	23.80	24.03	24.27	24.51	24.75	24.99	25.22	25.46	25.70	25.94	26.18
11	28.80	29.08	29.37	29.66	29.95	30.24	30.52	30.81	31.10	31.39	31.68
12	34.27	34 61	34.95	35.29	35.64	35.98	36.32	36.66	37.01	37.35	37.69
13	40.22	40.62	41.02	41.42	41.82	42.23	42.63	43.03	43.43	43.83	44.24
14	46.64	47.10	47.57	48 04	48.50	48.97	49.43	49.90	50.37	50.83	51.30
15	53.55	54.08	54.62	55.15	55 69	56.22	56.76	57.29	57.83	58.36	58.90
16	60.94	61.54	62.15	62.76	63.37	63.98	64.59	65.20	65.81	66.42	67.03
17	68.78	69.46	70.15	70 84	71.53	72 21	72.90	73.59	74.28	74.97	75.65
18	77.11	77.88	78.65	79 42	80.19	80.96	81.73	82.51	83.27	84.05	84.82
19	85.91	86.76	87.63	88.48	89.34	90.20	91.06	91.92	92.78	93.64	94.50
20	95.20	96.15	97.10	98.05	99.00	99.96	100.91	101.86	102.81	103.76	104.72
21	104.96	106.01	107.05	108.11	109.15	110.21	111.25	112.31	113.35	114.41	115.45
22	115.20	116.35	117.50	118.65	119.81	120.96	122.11	123.26	124.41	125.56	126.72
23	125.90	127.15	128.41	129.67	130 93	132.19	133.45	134.71	135.97	137.23	138.49
24	137.08	138.45	139.82	141.19	142.57	143.94	145 31	146.68	148.05	149.42	150.79
25	148.75	150.23	151.72	153 21	154.70	156.18	157.67	159.16	160.65	162.13	163.62
26	160.89	162.49	164.10	165.71	167.32	168.93	170.54	172.15	173.76	175.37	176.97
27	173.50	175.23	176.97	178.70	180.44	182.17	183.91	185.64	187.38	189.11	190.85
28	186.59	188.45	190.32	192.18	194.05	195.91	197.78	199.65	201.51	203.39	205.24
29	200.15	202.15	204.15	206.15	208.15	210.15	212.15	214.16	216.16	218.16	220.16
30	214.20	216.34	218.48	220.62	222.76	224.91	227.05	229.19	231.33	233.47	235.62
31	228.70	230.98	233.27	235.56	237.84	240.13	242.42	244.71	246.99	249.28	251.57
32	243.70	246.13	248.57	251.01	253.44	255.88	258.32	260.75	263.19	265.63	268.07
33	259.18	261.77	264 36	266.95	269.54	272.13	274.73	277.32	279.91	282.50	285.09
34	275.13	277.88	280.63	283.38	286.13	288.88	291.63	294.38	297.14	299.89	302.64
35	291.55	294.46	297.38	300.29	303 21	306.12	309.04	311.95	314.87	317.78	320.70
36	308.43	311.51	314.59	317.68	320.76	323.85	326.93	330.02	333.10	336.18	339.27
37	325.80	329.05	332.31	335.57	338.83	342.09	345.34	348.60	351.86	355.12	358.38
38	343.66	347.09	350.53	353.96	357.40	360.84	364.27	367.71	371.15	374.58	378.02
39	362.00	365.62	369.24	372 86	376.48	380.10	383.72	387.34	390.96	394.58	398.20
40	380.80	384.61	388.41	392.22	396.03	399.84	403.64	407.45	411.26	415.07	418.88
41	400.06	404.06	408.06	412.06	416.06	420.06	424.06	428.06	432.06	436.06	440.06
42	419.82	424.01	428.21	432.41	436.61	440.81	445.00	449.20	453.40	457.60	461.80
43	440.06	444.46	448.86	453.26	457.66	462.06	466.46	470.86	475.26	479.66	484.06
44	460 76	465.36	469.97	474.58	479.19	483.79	488.40	493.01	497.62	502.22	506.83
45	481.94	486.75	491.57	496.39	501.21	506.03	510.85	515.67	520.49	525.31	530.13
46	503.61	508.64	513.68	518.71	523.75	528.79	533.82	538.86	543.89	548.93	553.97
47	525.73	530.98	536.24	541.50	546.75	552.01	557.27	562.53	567.78	573.04	578.30
48	548.33	553.81	559.29	564.77	570.26	575.74	581.22	586.71	592.19	597.67	603.16
49	571.42	577.13	582.84	588.56	594 27	599.99	605.70	611.41	617.13	622.84	628.56
50	595.00	600.95	606.90	612.85	618 80	624.75	630.70	636.65	642.60	648.55	654.50
51	619.03	625.22	631.41	637.60	643.79	649.98	656.17	662.36	668.55	674.74	680.93
52	643.54	649.97	656.41	662.84	669.28	675.71	682.15	688.58	695.02	701.45	707.89
53	668.51	675.19	681.88	688.56	695.25	701.93	708.62	715.30	721.99	728.67	735.36
54	694.00	700.94	707.88	714.82	721.76	728.70	735.64	742.58	749.52	756.46	763.40
55	719.94	727.13	734.33	741.53	748.73	755.93	763.13	770.33	777.53	784.73	791.93
56	746.36	753.82	761.28	768.75	776.21	783.67	791.14	798.60	806.06	813.53	820.99
57	773.24	780.97	788.70	796.43	804.16	811.90	819.63	827.36	835.09	842.83	850.56
58	800.61	808.61	816.62	824.62	832.63	840.64	848.64	856.65	864.65	872.66	880.67
59	828.45	836.73	845.01	853.30	861 58	869.87	878.15	886.44	894.72	903.01	911.29
60	856.79	865.35	873.92	882.49	891.06	899.62	908.19	916.76	925.33	933.90	942.46

No. 5.—*Continued.*

Diameter.	PRESSURE.									
	111	112	113	114	115	116	117	118	119	120
8	16.90	17.05	17.20	17.36	17.51	17.66	17.81	17.97	18.12	18.27
9	21.38	21.58	21.77	21.96	22.16	22.35	22.54	22.75	22.93	23.12
10	26.41	26.65	26.89	27.13	27.37	27.61	27.84	28.08	28.33	28.56
11	31.96	32.25	32.54	32.83	33.12	33.40	33.69	33.98	34.27	34.56
12	38.04	38.38	38.72	39.06	39.41	39.75	40.09	40.43	40.78	41.12
13	44.64	45.04	45.44	45.85	46.25	46.65	47.05	47.45	47.86	48.26
14	51.77	52.23	52.70	53.16	53.63	54.10	54.56	55.03	55.50	55.97
15	59.44	59.97	60.51	61.04	61.58	62.11	62.65	63.18	63.72	64.26
16	67.64	68.25	68.86	69.47	70.08	70.69	71.29	71.91	72.51	73.12
17	76.34	77.03	77.72	78.41	79.09	79.78	80.47	81.16	81.84	82.52
18	85.59	86.36	87.13	87.90	88.67	89.41	90.22	90.98	91.76	92.53
19	95.36	96.22	97.07	97.93	98.79	99.65	100.51	101.37	102.23	103.09
20	105.67	106.62	107.57	108.52	109.48	110.43	111.38	112.33	113.28	114.24
21	116.50	117.55	118.60	119.65	120.70	121.75	122.80	123.85	124.90	125.95
22	127.87	129.02	130.17	131.32	132.48	133.63	134.78	135.93	137.08	138.24
23	139.74	141.00	142.26	143.52	144.78	146.04	147.30	148.56	149.82	151.08
24	152.16	153.53	154.90	156.27	157.65	159.02	160.39	161.76	163.13	164.50
25	165.11	166.60	168.08	169.57	171.06	172.55	174.03	175.52	177.01	178.50
26	178.58	180.19	181.80	183.41	185.02	186.63	188.24	189.85	191.45	193.06
27	192.58	194.32	196.05	197.79	199.52	201.26	202.99	204.73	206.46	208.20
28	207.11	208.98	210.84	212.71	214.57	216.44	218.31	220.17	222.04	223.90
29	222.16	224.16	226.16	228.16	230.17	232.17	234.17	236.17	238.17	240.18
30	237.76	239.90	242.04	244.18	246.32	248.47	250.61	252.75	254.89	257.04
31	253.85	256.14	258.43	260.71	263.00	265.29	267.57	269.86	272.15	274.44
32	270.50	272.94	275.38	277.81	280.25	282.69	285.12	287.56	290.00	292.44
33	287.68	290.28	292.87	295.46	298.05	300.64	303.24	305.83	308.42	311.01
34	305.39	308.14	310.89	313.64	316.39	319.15	321.90	324.65	327.40	330.15
35	323.62	326.53	329.45	332.36	335.28	338.19	341.11	344.02	346.94	349.86
36	342.35	345.44	348.52	351.61	354.69	357.77	360.86	363.94	367.03	370.11
37	361.63	364.89	368.15	371.41	374.67	377.92	381.18	384.44	387.70	390.96
38	381.46	384.89	388.33	391.77	395.20	398.64	402.08	405.51	408.95	412.39
39	401.82	405.44	409.06	412.68	416.30	419.92	423.54	427.16	430.78	434.40
40	422.68	426.49	430.30	434.11	437.92	441.72	445.53	449.34	453.15	456.96
41	444.06	448.06	452.06	456.06	460.06	464.06	468.07	472.07	476.07	480.07
42	466.00	470.19	474.39	478.59	482.79	486.99	491.18	495.38	499.58	503.78
43	488.46	492.86	497.26	501.66	506.06	510.46	514.87	519.27	523.67	528.07
44	511.44	516.05	520.65	525.26	529.87	534.48	539.08	543.69	548.30	552.91
45	534.95	539.77	544.59	549.41	554.23	559.05	563.86	568.68	573.50	578.32
46	559.00	564.04	569.07	574.11	579.15	584.18	589.22	594.25	599.29	604.33
47	583.56	588.81	594.07	599.33	604.58	609.84	615.10	620.36	625.61	630.87
48	608.64	614.12	619.61	625.09	630.57	636.06	641.54	647.02	652.51	657.99
49	634.27	639.99	645.70	651.41	657.13	662.84	668.56	674.27	679.98	685.70
50	660.45	666.40	672.35	678.30	684.25	690.20	696.15	702.10	708.05	714.00
51	687.12	693.31	699.50	705.69	711.88	718.07	724.26	730.45	736.64	742.83
52	714.32	720.76	727.20	733.63	740.07	746.50	752.94	759.37	765.81	772.24
53	742.04	748.73	755.41	762.10	768.78	775.47	782.15	788.84	795.52	802.21
54	770.34	777.28	784.22	791.16	798.10	805.04	811.98	818.92	825.86	832.80
55	799.13	806.33	813.53	820.73	827.93	835.13	842.32	849.52	856.72	863.92
56	828.45	835.92	843.38	850.85	858.31	865.77	873.24	880.70	888.16	895.63
57	858.29	866.02	873.76	881.49	889.22	896.95	904.69	912.42	920.15	927.88
58	888.67	896.68	904.68	912.69	920.70	928.70	936.71	944.71	952.72	960.73
59	919.57	927.86	936.14	944.43	952.71	961.00	969.28	977.57	985.85	994.14
60	951.03	959.60	968.17	976.74	985.30	993.87	1002.44	1011.01	1019.58	1028.14

Note A.

The probable per cent loss of power by different engines.

Accurately finished high pressure engines allow 15 per cent loss.

Ordinarily finished high pressure engines allow 20 per cent loss.

Accurately finished condensing engines allow 25 per cent loss.

Ordinarily finished condensing engines allow 30 per cent loss.

Note B.

No. 83 Problem requires the diameter of a cylinder to produce 28 effective horse power; but the horse power of the engines in the table is the theoretical power; hence the effective power must be increased to the theoretical power; the effective power in this problem is 20 per cent less than the theoretical power; suppose the theoretical power of an engine to be 50 horse power, and the loss power of the engine being 20 per cent, then, the effective power of the engine will be 40 horse power; now 25 per cent of 40 added to 40 equals 50; hence 25 per cent of the effective power is equal to 20 per cent of the theoretical power; from this relation between the theoretical and effective power the following statement is made.

1765 per cent of the effective power is equal to 15 per cent of the theoretical power.

25 per cent of the effective power is equal to 20 per cent of the theoretical power.

3333 per cent of the effective power is equal to 25 per cent of the theoretical power.

4286 per cent of the effective power is equal to 30 per cent of the theoretical power.

Note C.

The velocity of the piston in 83 Problem is 250 feet per minute, but the velocity of the piston represented in the table is 100 feet; hence the velocity of the piston in No. 83 Problem must be reduced to 100 feet per minute, which is done by dividing the effective power in 83 Problem by 2.50, because 250 divided by 100 gives 2.50.

COTTON MANUFACTURING.

COTTON MANUFACTURING.

The following table shows the usual cost of a brick factory after the foundation is finished, (see note P,) to contain different number of mule and frame spindles on No. 25 yarn with looms; and also, the cost of the water wheel (overshot or breast,) engines, gearing and belting.

EXAMPLE.

Required, the usual cost of a brick factory to contain 4000 mule and frame spindles, with looms on No. 25 yarn; also, the cost of the water wheels to drive the same—find 4000 in the column marked "Spindles," opposite to this number in the column marked "Building," will be found 11324 dollars; and also in the column marked "Wheels," will be found 1280 dollars.—*Answer.*

EXAMPLE.

Required, the cost of an engine to drive 6000 mule and frame spindles on No. 25 yarn, with looms; and also the cost of the belting and gearing—find 6000 in the column marked "Spindles," opposite to this number in the column marked "Engine," will be found 7250 dollars; and also in the column marked "Gearing," will be found 2556 dollars; and in the column marked "Belting," will be found 1460 dollars.—*Answer.*

No. 1.

Spindles.	Building.	Wheels.	Engine.	Gearing.	Belting.
1000	3056	350	1500	500	260
2000	5812	660	2650	911	500
3000	8568	970	3800	1319	740
4000	11324	1280	4950	1733	980
5000	14080	1590	6100	2142	1220
6000	16836	1900	7250	2556	1460
7000	19592	2210	8400	2965	1700
8000	22348	2520	9550	3376	1949
9000	25104	2830	10700	3787	2180
10000	27860	3140	11850	4198	2420

The following table shows the length of the building, which is three stories high and of different widths; to contain different number of spindles with looms: this table is calculated for the table which shows the attendant machinery for different number of spindles, in which there is double carding.

EXAMPLE.

Required, the length of a building to contain 3000 spindles with looms, the width being 40 feet, and the building being three stories high—find 3000 in the column marked "Spindles," opposite to this number in the table, and under

No. 2.

	WIDTH.								
Spindls.	40	42	44	46	48	50	52	54	56
1000	42	40	38	36	34	33	32	31	30
2000	84	80	76	72	68	66	64	62	60
3000	126	120	114	108	102	99	96	93	90
4000	168	160	152	144	136	132	128	124	120
5000	210	200	190	180	170	165	160	155	150
6000	252	240	228	216	204	198	192	186	180
7000	294	280	266	252	238	231	224	217	210
8000	336	320	304	288	272	264	256	248	240
9000	378	360	342	324	306	297	288	279	270
10000	420	400	380	360	340	330	320	310	300

40 in the column marked "Width," will be found 126 feet. —*Answer.*

EXAMPLE.

Required, the length of a building to contain 6000 spindles with looms, the width being 50 feet, and the building being four stories high—find 6000 in the column marked "Spindles," opposite to this number in the table, and under 50 in the column marked "Width," will be found 198 feet; now if three stories require 198 feet, four stories will by simple proportion require but 149 feet.—*Answer.*

The following tables show the number of horse power required to drive different number and kind of spindles with looms, on different numbers of yarn. The column marked "Frame Spindles," shows that the filling and warp yarn is spun on frames, which includes all kind of frames, except the cap or Danforth frame. When the warp and filling is spun on this frame, add one horse power to every 500 spindles. This frame produces more per spindle than others, consequently there will be more attendant machinery, hence the increase of power. The column marked "Calculated Power," shows the usual horse power of the engine or water wheel. The column marked "Actual Power," shows the actual power required, which is 25 per cent less than the power of the engine or wheel: hence there should be 25 per cent surplus power in the engine or wheel above what is required to drive the machinery.

EXAMPLE.

Required, the horse power of an engine to drive 2000 mule and frame spindles with looms, the number of yarn being 25—find 2000 in the column marked "Mule and Frame Spindles," opposite to this number in the column marked "Calculated Power," will be found 30 horse power. In the column marked "Actual Power," will be found 22.5 horse power, the actual power required to drive 2000 mule and frame spindles with looms, on No. 25 yarn.—*Answer.*

No. 3.

No. 10 to 20 Yarn. No. 20 to 30 Yarn. No. 30 to 40 Yarn.

Frame Spindles	Calc Pow.	Actual Power.	Frame Spindles	Calc Pow	Actual Power.	Frame Spindles	Calc. Pow.	Actual Power.
1000	19	14.25	1000	17	12.75	1000	16	12
2000	38	28.50	2000	34	25.50	2000	32	24
3000	57	42.75	3000	51	38.25	3000	48	36
4000	76	57.00	4000	68	51.00	4000	64	48
5000	95	71.25	5000	85	63.75	5000	80	60
6000	114	85.50	6000	102	76.50	6000	96	72
7000	133	99.75	7000	119	89.25	7000	112	84
8000	152	114.00	8000	136	102.00	8000	128	96
9000	171	128.25	9000	153	114.75	9000	144	108
10000	190	142.50	10000	170	127.50	10000	160	120

No. 10 to 20 Yarn. No. 20 to 30 Yarn. No. 30 to 40 Yarn.

Mule & Frame Spindles	Calcu la.ed Pow.	Actual Power.	Mule & Frame Spindles	Calcu lated Pow.	Actual Power.	Mule & Frame Spindles	Calcu lated Pow.	Actual Power.
1000	17	12.75	1000	15	11.25	1000	14	10.50
2000	34	25.50	2000	30	22.50	2000	28	21.00
3000	51	38.25	3000	45	33 75	3000	42	31.50
4000	68	51.00	4000	60	45.00	4000	56	42.00
5000	85	63.75	5000	75	56.25	5000	70	52.50
6000	102	76.50	6000	90	67.50	6000	84	63.00
7000	119	89.25	7000	105	78.75	7000	98	73.50
8000	136	102.00	8000	120	90.00	8000	112	84.00
9000	153	114.75	9000	135	101.25	9000	126	94.50
10000	170	127.50	10000	150	112 50	10000	140	105.00

No. 10 to 20 Yarn. No. 20 to 30 Yarn. No. 30 to 40 Yarn.

Mule Spindles	Calc. Pow.	Actual Power.	Mule Spindles	Calc. Pow.	Actual Power.	Mule Spindles	Calc Pow	Actual Power.
1000	16	12	1000	14	10.50	1000	13	9.75
2000	32	24	2000	28	21 00	2000	26	19.50
3000	48	36	3000	42	31.50	3000	39	29.25
4000	64	48	4000	56	42.00	4000	52	39.00
5000	80	60	5000	70	52.50	5000	65	48.75
6000	96	72	6000	84	63.00	6000	78	58.50
7000	112	84	7000	98	73.50	7000	91	68.25
8000	128	96	8000	112	84.00	8000	104	78.00
9000	144	108	9000	126	94.50	9000	117	87.75
10000	160	120	10000	140	105.00	10000	130	97 50

EXAMPLE.

Required, the horse power of a water wheel, to drive 6000 mule spindles with looms, the number of the yarn being 36—find 6000 in the column marked "Mule Spindles," opposite to this number in the column marked "Calculated Power," will be found 78 horse power; in the column marked "Actual Power," will be found 58.5 horse power, the actual power required to drive 6000 mule spindles with looms, on No. 36 yarn.—*Answer.*

The following tables show the required length of overshot and breast water wheels on different falls, to drive different number and kind of spindles with looms on different numbers

No. 4.

MULE SPINDLES WITH LOOMS NO 10 TO 25 YARN.

Fall.	No. SPINDLES.									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	7.6	15.2	22.8	30.4	38.0	45.6	53.2	60.8	68.4	76
11	7 0	14.0	21.0	28.0	35.0	42 0	49.0	56.0	63.0	70
12	6.3	12 6	18.9	25.2	31.5	37.8	44.1	50.4	56.7	63
13	6 0	12.0	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60
14	5.4	10.8	16.2	21.6	27.0	32.4	37.8	43.2	48.6	54
15	5 0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50
16	4.7	9.4	14.1	18.8	23.5	28.2	32.9	37.6	42 3	47
17	4.5	9.0	13.5	18.0	22.5	27.0	31.5	36.0	40.5	45
18	4.2	8 4	12.6	16.8	21 0	25.2	29.4	33.6	37.8	42
19	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40
20	3.8	7.6	11.4	15.2	19.0	22.8	26.6	30.4	34.2	38
21	3.6	7.2	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36
22	3.4	6.8	10.2	13.6	17.0	20.4	23.8	27.2	30.6	34
23	3.3	6.6	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33
24	3.1	6.2	9.3	12.4	15.5	18.6	21.7	24.8	27.9	31
25	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30
26	2.9	5.8	8.7	11.6	14.5	17.4	20.3	23.2	26.1	29
27	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28
28	2.7	5.4	8.1	10.8	13.5	16.2	18·9	21.6	24 3	27
29	2.6	5.2	7.8	10.4	13.0	15.6	18.2	20.8	23.4	26
30	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25

of yarn: the *length* of the wheel means the *length* of the buckets in the *clear*, that is the length of the space in the wheel which the water occupies; this must be particularly observed—the column marked "Fall," shows the fall of the breast, or the diameter of the overshot wheel; the fall of the breast wheel is supposed to be two feet, (see Notes on Water Power,) the column marked "No. of Spindles," shows the number of spindles with looms, to be driven.

Example.

Required, the length of an overshot wheel to drive 2000 frame spindles with looms, on any number of yarn from 10 to 25, the diameter of the wheel being 12 feet—find 12 in

No. 5.

Mule Spindles with Looms No. 25 to 40 Yarn.

	No. SPINDLES.									
Fall.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	6.6	13 2	19.8	26.4	33.0	39.6	46.2	52.8	59.4	66.0
11	6.0	12.0	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0
12	5.5	11.0	16.5	22.0	27.5	33.0	38.5	44.0	49.5	55.0
13	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
14	4.7	9.4	14.1	18.8	23.5	28.2	32.9	37.6	42 3	47.0
15	4.4	8.8	13.2	17.6	22.0	26.4	30.8	35.2	39.6	44.0
16	4.1	8.2	12.3	16.4	20.5	24.6	28.7	32.8	36.9	41.0
17	3.9	7.8	11.7	15.6	19.5	23.4	27.3	31.2	35.1	39.0
18	3.7	7.4	11.1	14.8	18.5	22.2	25.9	29.6	33.3	37.0
19	3.5	7.0	10.5	14.0	17.5	21.0	24.5	28.0	31.5	35.0
20	3.3	6.6	9.9	13.2	16.5	19.8	23 1	26.4	29.7	33.0
21	3.1	6.2	9.3	12.4	15.5	18.6	21.7	24.8	27.9	31.0
22	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
23	2.9	5.8	8.7	11.6	14.5	17.4	20.3	23.2	26.1	29.0
24	2.8	5.5	8.2	11.0	13.7	16.5	19.2	22.0	24.7	27.5
25	2.6	5.2	7.8	10.4	13.0	15.6	18.2	20.6	23.4	26.0
26	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25.0
27	2.4	4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
28	2.3	4 7	7.0	9.4	11.7	14.1	16.4	18.8	21.1	23.5
29	2.3	4.6	6.9	9.2	11.5	13.8	16 1	18.4	20.7	23.0
30	2.2	4.4	6.6	8.8	11.0	13.2	15.4	17.6	19.8	22.0

the column marked "Fall," opposite to this number in the table, and under 2000 in the column marked "No. of Spindles," will be found 16 feet, the length of the bucket in the clear.—*Answer.*

EXAMPLE.

Required, the length of an overshot wheel to 8000 mule and frame spindles with looms, on any number of yarn from 10 to 25, the diameter of the wheel being 22 feet—find 22 in the column marked "Fall," opposite to this number in the table, and under 8000 in the column marked "No. of Spindles," will be found 32 feet the length of the bucket in the clear, or two wheels 16 feet each in the clear.—*Answer.*

No. 6.

MULE AND FRAME SPINDLES WITH LOOMS No. 10 TO 25 YARN.

Fall.	No. SPINDLES.									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	8.7	17.4	26.1	34.8	43.5	52.2	60.9	69.6	78 3	87.0
11	8.0	16.0	24.0	32.0	40.0	48.0	56.0	64.0	72.0	80.0
12	7.2	14.4	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0
13	6.7	13.4	20.1	26.8	33.6	40.3	47.0	53.7	60.4	67.2
14	6.2	12.5	18.7	25.0	31.2	37.5	43.7	50.0	56.2	62.5
15	5.8	11.6	17 4	23.2	29.1	34 9	40.7	46 5	52 3	58.2
16	5.5	11.0	16.5	22.0	27.5	33.0	38.5	44.0	49 5	55.0
17	5 2	10 4	15.6	20.8	26.0	31.2	36.4	41.6	46.8	52.0
18	4.9	9.8	14.7	19.6	24.5	29.4	34.3	39.2	44.1	49.0
19	4.6	9.2	13.8	18.4	23.0	27.6	32.2	36.8	41.4	46.0
20	4.3	8.7	13.1	17.4	21.8	26.1	30.5	34.8	39.2	43.6
21	4.1	8.2	12.4	16.5	20.7	24.8	28.9	33.1	37.2	41.4
22	3.9	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0
23	3.8	7.6	11.4	15.2	19.3	22.8	26.6	30.4	34.2	38.0
24	3.6	7.2	10.8	14.4	18 4	21.6	25.2	28.8	32.4	36.0
25	3.4	6.8	10.2	13.6	17.4	20.4	23 8	27.2	30.6	34.0
26	3.3	6.6	9.9	13 2	16.5	19.8	23.1	26.4	29.7	33.0
27	3 2	6.4	9.6	12.8	16.0	19.2	22.4	25.6	28.8	32.0
28	3.1	6.2	9.3	12.4	15.5	18.6	21.7	24.8	27.9	31.0
29	3.0	6 0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
30	2.9	5.8	8.7	11.6	14.5	17.4	20.3	23.2	26.1	29.0

Example.

Required, the length of a breast wheel to drive 2000 mule spindles with looms, on any number of yarn from 25 to 40, the fall being 10 feet—find 10 in the column marked "Fall," opposite to this number in the table, and under 2000 in the column marked "No. of Spindles," will be found 13.2 feet the length of the bucket in the clear; if an iron and wood wheel are equal in length, the difference in the length of the buckets will be from one to two feet; hence the length of the bucket in the clear must always be observed.—*Answer.*

No. 7.

Mule and Frame Spindles with Looms No. 25 to 40 Yarn.

	No. SPINDLES.									
Fall.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	7.6	15.2	22.8	30.4	38.0	45 6	53.2	60 8	68.4	76
11	7.0	14.0	21.0	28.0	35.0	42.0	49.0	56.0	63.0	70
12	6.3	12.6	18.9	25.2	31.5	37.8	44.1	50.4	56 7	63
13	6.0	12.0	18.0	24 0	30.0	36.0	42.0	48.0	54.0	60
14	5.4	10.8	16.2	21.6	27.0	32.4	37.8	43 2	48.6	54
15	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50
16	4.7	9.4	14.1	18.8	23.5	28.2	32.9	37.6	42 3	47
17	4.5	9.0	13.5	18.0	22.5	27.0	31.5	36.0	40.5	45
18	4.2	8.4	12 6	16.8	21.0	25.2	29.4	33.6	37.8	42
19	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40
20	3.8	7.6	11.4	15.2	19.0	22 8	26.6	30.4	34.2	38
21	3.6	7.2	10.8	14.4	18.0	21.6	25 2	28.8	32.4	36
22	3.4	6.8	10.2	13.6	17.0	20.4	23 8	27.2	30 6	34
23	3.3	6 6	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33
24	3.1	6.2	9.3	12.4	15.5	18.6	21.7	24.8	27.9	31
25	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24 0	27.0	30
26	2.9	5.8	8.7	11.6	14.5	17.4	20.3	23.2	26.1	29
27	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28
28	2.7	5.4	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27
29	2.6	5.2	7.8	10.4	13.0	15.6	18 2	20 8	23.4	26
30	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0	22.5	25

It will be noticed that the number of yarn in these tables range, from 10 to 25, and 25 to 40; if a greater degree of accuracy is required, or the length of the wheel required, say for No. 30 yarn, it can be found by referring to the table showing the calculated and actual power required to drive different number and kind of spindles with looms on different numbers of yarn; after the number of horse power is found, refer to the table showing the horse power of overshot and breast wheel on different falls, and of different length.

No. 8.

FRAME SPINDLES WITH LOOMS No. 10 TO 20 YARN.

	No. SPINDLES.									
Fall.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	10 3	20.6	30.9	41.2	51.5	61.8	72.1	82.4	92.7	103.0
11	9 3	18 6	27 9	32 2	46.5	55.8	65.1	74.4	83.7	93.0
12	8·6	17.2	25 8	34.4	43.0	51.6	60.2	68 8	77 4	86.0
13	8.0	16.0	24.0	32.0	40.0	48.0	56.0	64.0	72.0	80.0
14	7.3	14.6	21 9	29.2	36 5	43.8	51.1	58.4	65.7	73.0
15	7.0	14 0	21.0	28.0	35.0	42.0	49.0	56.0	63.0	70.0
16	6.4	12.8	19.2	25.6	32.0	38.4	44 8	51.2	57.6	64.0
17	6.0	12.0	18.0	24·0	30.0	36.0	42.0	48.0	54.0	60 0
18	5.7	11.4	17.1	22.8	28.5	34.2	39.9	45.6	50.3	57.0
19	5.4	10.8	16.2	21.6	27.0	32 4	37.8	43 2	48.6	54.0
20	5 1	10 2	15.3	20.4	25.5	30.6	35.7	40.8	45.9	51.0
21	4.9	9.8	14.7	19.6	24.5	29.4	34.3	39 2	44.1	49.0
22	4.7	9.4	14.1	18.8	23.5	28.2	32 9	37 6	42.3	47.0
23	4.5	9.0	13.5	18 0	22.5	27.0	31.5	36.0	40.5	45.0
24	4.3	8.6	12.9	17 2	21.5	25.8	30.1	34.4	38.7	43.0
25	4.1	8.2	12.3	16 4	20.5	24.6	28.7	32.8	36.9	41.0
26	3.9	7.8	11.7	15.6	19.5	23 4	27.3	31.2	35 1	39.0
27	3.8	7 6	11.4	15.2	19.0	22.8	26 6	30.4	34.2	38.0
28	3 7	7.4	11.1	14.8	18.5	22 2	25.9	29.6	33.3	37.0
29	3.5	7.0	10 5	14.0	17.5	21.0	24 5	28.0	31.5	35.0
30	3.4	6.8	10.2	13 6	17.0	20.4	23.8	27.2	30.6	34.0

No. 9.

FRAME SPINDLES WITH LOOMS No. 25 TO 40 YARN.

Fall.	No. SPINDLES.									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	8.7	17.4	26.1	34.8	43.5	52.2	60.9	69.6	78.3	87.0
11	8.0	16 0	24.0	32 0	40.0	48.0	56.0	64.0	72.0	80 0
12	7.2	14.4	21.6	28 8	36.0	43.2	50.4	57.6	64.8	72.0
13	6.7	13.4	20.1	26.8	33.6	40.3	47.0	53.7	60.4	67.2
14	6.2	12.5	18.7	25.0	31.2	37.5	43.7	50.0	56.2	62.5
15	5.8	11.6	17.4	23.2	29.1	34.9	40.7	46.5	52.3	58.2
16	5.5	11.0	16 5	22.0	27.5	33.0	38.5	44 0	49.5	55.0
17	5.2	10.4	15.6	20.8	26.0	31.2	36.4	41.6	46 8	52.0
18	4.9	9.8	14.7	19.6	24.5	29.4	34.3	39.2	44.1	49.0
19	4.6	9.2	13.8	18 4	23.0	27.6	32.2	36.8	41.4	46.0
20	4.3	8.7	13 1	17.4	21.8	26.1	30.5	34.8	39.2	43.6
21	4.1	8.2	12.4	16 5	20.7	24.8	28.9	33.1	37.2	41.4
22	4.0	8.0	12.0	16.0	20 0	24.0	27.8	32.0	36.0	40.0
23	3.8	7.6	11.4	15.2	19.3	22.8	26.6	30.4	34.2	38.0
24	3.6	7.2	10.8	14.4	18.4	21.6	25.2	28.8	32.4	36.0
25	3.4	6 8	10.2	13.6	17.4	20.4	23.8	27.2	30.6	34.0
26	3.3	6.6	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33.0
27	3.2	6.4	9.6	12.8	16.0	19.2	22.4	25.6	28.8	32.0
28	3.1	6.2	9.3	12 4	15.5	18.6	21.7	24.8	27.9	31 0
29	3.0	6.0	9.0	12 0	15 0	18.0	21.0	24.0	27 0	30 0
30	2.9	5.8	8 7	11.6	14.5	17.4	20.3	23.2	26.1	29.0

The following table shows the required area of all the openings in the outward discharging turbine wheel, to drive different number of spindles under different heads: the column marked "Head," shows the number of feet head, the column marked "No. of Spindles," shows the number of spindles to be driven.—(See Note B.)

EXAMPLE.

Required, the area of all the openings in an outward discharging turbine wheel, the head being 16 feet, to drive 3000 spindles with looms, on No. 20 yarn—find 16 in the column marked "Head," opposite to this number in the table, and

under 3000 in the column marked "Spindles," will be found 200 inches area.—*Answer.*

EXAMPLE.

Required, the area of all the openings in an outward discharging turbine wheel, the head being 20 feet, to drive 2000 spindles on No. 25 yarn, with looms—find 20 in the column marked "Head," opposite to this number in the table, and under 2000 in the column marked "Spindles," will be found 103 inches area.—*Answer.*

No. 10.

THE OUTWARD DISCHARGING TURBINE WATER WHEEL MULES AND FRAMES AND WEAVING ON No. 18 TO 25 YARN.

	SPINDLES.									
Head	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
5	558	744	930	1116	1302	1488	1674	1860	2046	2232
6	363	484	605	726	847	968	1089	1210	1331	1452
7	311	415	519	623	727	831	935	1039	1143	1247
8	245	327	409	491	573	655	737	819	901	983
9	190	253	316	379	442	505	568	631	694	757
10	163	217	271	325	379	433	487	541	595	649
11	137	183	229	275	321	367	413	459	505	551
12	122	163	204	245	286	327	368	409	450	491
13	107	143	179	215	251	287	323	359	395	431
14	95	127	159	191	223	255	287	319	351	383
15	83	111	139	167	195	223	251	279	307	335
16	75	100	125	150	175	200	225	250	275	300
17	68	91	114	137	160	183	206	229	252	275
18	62	83	104	125	146	167	188	209	230	251
19	57	76	95	114	133	152	171	190	209	228
20	52	69	86	103	120	137	154	171	188	205
21	48	64	80	96	112	128	144	160	176	192
22	45	60	75	90	105	120	135	150	165	180
23	43	57	71	85	99	113	127	141	155	169
24	39	52	65	78	91	104	117	130	143	156
25	37	49	61	73	85	97	109	121	133	145
26	35	47	59	71	83	95	107	119	131	143
27	32	43	54	65	76	87	98	109	120	131
28	31	41	51	61	71	81	91	101	111	121
29	29	39	49	59	70	79	89	100	109	119
30	28	37	46	55	64	73	82	91	100	109

The following table shows the required area of all the openings in the inward discharging turbine wheel, to drive different number of spindles under different heads—the column marked "Head," shows the number of feet head, the column marked "Spindles," shows the number of spindles to be driven. (See Note B.)

EXAMPLE.

Required, the area of all the openings in an inward discharging turbine wheel, the head being 12 feet, to drive 2000

No. 11.

THE INWARD OR CENTRE DISCHARGING TURBINE WATER WHEEL MULES AND FRAMES AND WEAVING ON No. 18 TO 25 YARN.

	SPINDLES.									
Head	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
5	1000	1333	1666	1999	2332	2665	2998	3331	3664	3997
6	714	952	1190	1428	1666	1904	2142	2380	2618	2856
7	543	624	805	986	1167	1348	1529	1710	1891	2072
8	431	574	717	860	1003	1146	1289	1432	1575	1718
9	352	469	586	703	820	937	1054	1171	1288	1405
10	294	392	490	588	686	784	882	980	1078	1176
11	252	336	420	504	588	672	756	840	924	1008
12	217	289	361	433	505	577	649	721	793	865
13	190	253	316	379	442	505	568	631	694	755
14	169	225	281	337	393	449	505	561	617	673
15	151	201	251	301	351	401	451	501	551	601
16	136	181	226	271	316	361	406	451	496	541
17	123	164	205	246	287	328	369	410	451	492
18	113	151	189	227	265	303	341	379	417	455
19	104	139	174	209	244	279	314	349	384	419
20	96	128	160	192	224	256	288	320	352	384
21	88	117	146	175	204	233	262	291	320	349
22	82	109	136	163	190	217	244	271	298	325
23	77	103	129	155	181	207	233	259	285	311
24	72	96	120	144	168	192	216	240	264	288
25	67	89	111	133	155	177	199	221	243	265
26	63	84	105	126	147	168	189	210	231	252
27	59	79	99	119	139	159	179	199	219	239
28	56	75	94	113	132	151	170	189	208	227
29	53	71	89	107	125	143	161	179	197	215
30	50	67	84	101	118	135	152	169	186	203

spindles and weaving on No. 25 yarn—find 12 in the column marked "Head," opposite to this number in the table, and under 2000 in the column marked "No. of Spindles," will be found 433 inches area.—*Answer.*

EXAMPLE.

Required, the area of all the openings in the inward discharging turbine wheel, the head being 24 feet, to drive 3000 spindles and weaving on No. 18 yarn—find 24 in the column marked "Head," opposite to this number in the table, and under 3000 in the column marked "No. of Spindles," will be found 192 inches area.—*Answer.*

The following table shows the attendant machinery for different number of spindles, and for different numbers of yarn. This table is calculated for double carding when the yarn is finer than No. 20.

EXAMPLE.

Required, the attendant machinery for 2000 spindles on No. 25 yarn—find 2000 in the column marked "Spindles," opposite to this number in the different columns will be found, 1 willower, 1 picker, 16 cards, 2 R. R. Heads, 2 drawing frames, 20 coarse speeder spindles, 80 fine speeder spindles, 56 spooler spindles, 2 warpers, 2 dressers, 56 looms.—*Answer.*

EXAMPLE.

Required, the attendant machinery for 4000 spindles on No. 8 yarn—find 4000 in the column marked "Spindles," opposite to this number in the different columns will be found, 1 willower, 3 pickers, 48 cards, 8 R. R. Heads, 8 drawing frames, 256 coarse speeder spindles, (fine speeder spindles not required on so coarse work,) 112 spooler spindles, 2 warpers, 4 dressers, 96 looms.—*Answer.*

No. 12.

No. 5 to 10 Yarn.

Average cost from different Mach Shops	Willowers.	Pickers, two Beaters.	Single Cardg. 30 in. Cards.	R. R. Heads.	3 Heads each Drawg. Frame	Spdr. Spindles.	Do. fine Do.	Mule and Frame Spindles.	Spooler Spindles.	Warpers.	Dressers.	Looms.
10555	1	1	12	2	2	64	"	1000	28	1	1	24
21035	1	2	24	4	4	128	"	2000	56	2	2	48
31015	1	3	36	6	6	192	"	3000	84	2	3	72
41395	1	3	48	8	8	256	"	4000	112	2	4	96
51875	1	4	60	10	10	320	"	5000	140	3	5	120
62255	1	5	72	12	12	384	"	6000	168	3	6	144
72730	1	6	84	14	14	448	"	7000	196	4	7	168
83190	2	7	96	16	16	512	"	8000	224	4	8	192
93570	2	8	108	18	18	576	"	9000	252	4	9	216
103650	2	8	120	20	20	640	"	10000	280	5	10	240
						No. 10 to 20 Yarn.						
10055	1	1	8	2	2	12	50	1000	28	1	1	28
19710	1	2	16	4	3	24	100	2000	56	1	2	56
29065	1	2	24	6	4	36	150	3000	84	2	3	84
38720	1	3	32	8	5	48	200	4000	112	2	4	112
48075	1	3	40	10	6	60	250	5000	140	3	5	140
57730	1	4	48	12	7	72	300	6000	168	3	6	168
67310	1	4	56	14	9	84	350	7000	196	4	7	196
76965	1	5	64	16	10	96	400	8000	224	4	8	224
86945	1	6	72	18	12	108	450	9000	252	5	9	252
96200	1	6	80	20	13	120	500	10000	280	5	10	280
						No. 20 to 30 Yarn.						
9345	1	1	8	1	1	10	40	1000	28	1	1	28
18515	1	1	16	2	2	20	80	2000	56	2	2	56
27010	1	2	24	3	2	30	120	3000	84	2	3	84
36280	1	2	32	4	3	40	160	4000	112	2	4	112
44875	1	2	40	5	3	50	200	5000	140	3	5	140
54145	1	3	48	6	4	60	240	6000	168	4	6	168
63090	1	3	56	7	4	70	280	7000	196	4	7	196
72360	1	3	64	8	5	80	320	8000	224	5	8	224
81080	1	4	72	9	6	90	360	9000	252	5	9	252
90350	1	4	80	10	7	100	400	10000	280	6	10	280
						No. 30 to 40 Yarn.						
8855	1	1	6	1	1	10	38	1000	28	1	1	25
16860	1	1	12	2	1	20	76	2000	56	1	2	50
25190	1	1	18	3	2	30	114	3000	84	2	2	75
33645	1	2	24	4	2	40	152	4000	112	2	3	100
41525	1	2	30	5	3	50	190	5000	140	3	3	125
49980	1	2	36	6	3	60	228	6000	168	3	4	150
58610	1	2	42	7	4	70	266	7000	196	4	5	175
66315	1	3	48	8	4	80	304	8000	224	4	5	200
74920	1	3	54	9	4	90	342	9000	252	5	6	225
83600	1	3	60	10	5	100	380	10000	280	5	7	250

If other speeders are preferred, the number of each kind can be found from the following statement:—

Non-twisting speeder, 10 spindles; twisting ditto, 25 spindles; fly frame, 50 spindles:—all producing the same amount of work on the same No. of yarn.

The following table shows the number of revolutions per minute that shafts make when driven by different size pulleys; two inches is the ordinary ratio of increase of the diameter of pulleys; the following table is calculated accordingly—opposite to each table will be found the number of revolutions per minute that the driving shaft is supposed to run; the column marked "Driving Pulleys," shows the diameter of the pulleys which are to go on to the driving shaft; the column marked "Driven Pulleys," shows the diameter of the pulleys which are to go on to the driven shaft.

EXAMPLE.

The driving shaft runs 120 turns per minute, the driving pulley on it is 14 inches in diameter; required, the diameter of the driven pulley on the centre shaft, so it will make 140 turns per minute—find 14 in the column marked "Driving Pulleys," opposite to this number in the table, find 140 over this number, and in the column marked "Driven Pulleys," will be found 12 inches.—*Answer.*

EXAMPLE.

A frame shaft is driven 136 turns per minute by a pulley 12 inches in diameter; required, the diameter of a pulley to drive the frame shaft 182 turns per minute—find 12 in the column marked "Driving Pulleys," (opposite to 114 revolutions,) opposite to this number in the table find 136, below this number in the same column will be found 182, opposite to which in the column marked "Driving Pulleys," will be found 16 inches, the diameter of the required pulley. —*Answer.*

No. 13.

96 Revolutions.

Driving Pulleys.	DRIVEN PULLEYS.							
	10	12	14	16	18	20	22	24
10	96	80	68	60	53	48	44	40
12	115	96	82	72	64	58	52	48
14	134	112	96	84	75	67	61	56
16	153	128	109	96	85	77	69	64
18	172	144	123	108	96	86	78	72
20	192	160	137	120	106	96	87	80
22	211	176	150	132	117	106	96	88
24	230	192	164	144	128	115	104	96
	98 Revolutions.							
10	98	81	70	61	54	49	45	41
12	118	98	84	73	65	59	53	49
14	137	114	98	86	76	68	62	57
16	157	131	112	98	87	78	71	65
18	176	147	126	110	98	88	80	73
20	196	163	140	122	109	98	89	82
22	216	179	154	134	120	108	98	90
24	235	196	168	147	131	117	107	98
	100 Revolutions.							
10	100	83	71	62	56	50	45	42
12	120	100	85	75	67	60	54	50
14	140	116	100	87	78	70	63	58
16	160	133	114	100	89	80	72	67
18	180	150	128	112	100	90	82	75
20	200	166	142	125	111	100	91	83
22	220	183	157	137	122	110	100	92
24	240	200	171	150	133	120	109	100
	102 Revolutions.							
10	102	85	73	64	57	51	46	42
12	122	102	87	76	68	61	56	51
14	143	119	102	89	79	71	65	59
16	163	136	116	102	91	82	74	68
18	184	153	131	115	102	92	83	76
20	204	170	145	127	113	102	93	85
22	224	187	160	140	125	112	102	93
24	245	204	175	153	136	122	111	102
	104 Revolutions.							
10	104	86	74	65	57	52	47	43
12	124	104	89	78	69	62	56	53
14	145	121	104	91	80	72	66	61
16	166	138	118	104	92	83	75	70
18	187	156	133	117	104	93	85	78
20	208	173	148	130	115	104	94	87
22	228	190	163	143	127	114	104	95
24	249	208	178	156	138	124	113	104

No. 13.—*Continued.*

106 Revolutions.

Driving Pulleys.	DRIVEN PULLEYS. 10	12	14	16	18	20	22	24
10	106	88	75	66	58	53	48	44
12	127	106	91	79	70	63	58	53
14	148	124	106	93	82	74	67	61
16	169	141	121	106	94	84	77	70
18	190	159	136	119	106	95	87	79
20	212	176	151	132	117	106	96	88
22	233	194	166	145	129	116	106	97
24	254	212	181	159	141	127	115	106
	108 Revolutions.							
10	108	90	77	67	60	54	49	45
12	129	108	92	81	72	64	58	54
14	151	126	108	94	84	75	68	63
16	172	144	123	108	96	86	78	72
18	194	162	138	121	108	97	88	81
20	216	180	154	135	120	108	98	90
22	237	198	169	148	132	118	108	99
24	259	216	185	162	144	129	117	108
	110 Revolutions.							
10	110	91	78	68	61	55	50	45
12	132	110	94	82	73	66	60	55
14	154	128	110	96	85	77	70	64
16	176	146	125	110	97	88	80	73
18	198	164	141	123	110	99	90	82
20	220	183	157	137	122	110	100	91
22	242	201	172	151	134	121	110	100
24	264	220	188	165	146	132	120	110
	112 Revolutions.							
10	112	93	80	70	62	56	51	46
12	134	112	96	84	74	67	61	56
14	156	130	112	98	87	78	71	65
16	179	149	128	112	99	89	81	74
18	201	168	144	126	111	100	91	84
20	224	186	160	140	124	112	101	93
22	246	205	176	154	136	123	111	102
24	268	224	192	168	149	134	122	112
	114 Revolutions.							
10	114	95	81	71	63	57	52	47
12	136	114	97	85	76	68	62	57
14	159	133	113	99	88	79	72	66
16	182	152	130	114	101	91	83	76
18	205	171	146	128	114	102	93	85
20	228	190	162	142	126	114	103	95
22	250	209	178	156	139	125	113	104
24	273	228	195	171	152	136	124	114

No. 13.—*Continued.*

116 Revolutions.

Driving Pulleys.	DRIVEN PULLEYS.							
	10	12	14	16	18	20	22	24
10	116	96	82	72	64	58	52	48
12	139	116	99	87	77	69	63	58
14	162	135	116	101	90	81	73	67
16	185	154	132	116	103	92	84	77
18	208	173	149	130	116	104	94	87
20	232	193	165	145	128	116	105	96
22	255	212	182	159	141	127	115	106
24	278	232	199	174	154	139	126	116
	118 Revolutions.							
10	118	98	84	73	65	59	53	49
12	141	118	101	88	78	70	64	59
14	165	137	117	103	91	82	75	68
16	188	157	134	118	104	94	85	78
18	212	176	151	132	118	106	96	88
20	236	196	168	147	131	118	107	98
22	259	216	185	162	144	129	118	108
24	283	236	202	176	157	141	128	118
	120 Revolutions.							
10	120	100	85	75	66	60	54	50
12	144	120	102	90	80	72	65	60
14	168	140	119	105	93	84	76	70
16	192	160	137	120	106	96	87	80
18	216	180	154	135	120	108	98	90
20	240	200	171	150	133	120	109	100
22	264	220	188	165	146	132	120	110
24	288	240	205	180	160	144	131	120
	122 Revolutions.							
10	122	101	87	76	67	61	55	50
12	146	122	104	91	81	73	66	60
14	170	142	122	106	94	85	77	71
16	195	162	139	122	108	97	88	81
18	219	183	156	137	121	109	99	91
20	244	203	174	152	135	122	110	101
22	268	223	191	167	148	134	122	111
24	292	244	209	183	162	146	133	121
	124 Revolutions.							
10	124	103	88	77	68	62	56	51
12	148	124	106	93	82	74	67	62
14	173	144	124	108	96	86	78	72
16	198	165	141	124	110	99	90	82
18	223	186	159	139	123	111	101	93
20	248	206	177	155	137	124	112	103
22	272	227	194	170	151	136	123	113
24	297	248	212	186	165	148	135	124

No. 13.—*Continued.*

126 Revolutions.

Driving Pulleys.	DRIVEN PULLEYS.							
	10	12	14	16	18	20	22	24
10	126	105	90	78	70	63	57	52
12	151	126	108	94	84	75	68	63
14	176	147	126	110	98	88	80	73
16	201	168	144	126	112	100	91	84
18	226	189	162	141	126	113	102	94
20	252	210	180	157	140	126	114	105
22	277	231	198	173	154	138	125	115
24	302	252	216	189	168	151	137	126
	128 Revolutions.							
10	128	106	91	80	71	64	58	53
12	153	128	109	96	85	76	69	64
14	179	149	128	112	99	89	81	74
16	204	170	146	128	113	102	92	85
18	230	191	164	144	128	115	104	96
20	256	213	182	160	142	128	116	106
22	281	234	200	176	156	140	127	117
24	307	255	219	192	170	153	139	128
	130 Revolutions.							
10	130	108	92	81	72	65	59	54
12	156	130	111	97	86	78	71	65
14	182	151	130	114	101	91	82	75
16	208	173	148	130	115	104	94	86
18	234	195	167	146	130	117	106	97
20	260	216	185	162	144	130	118	108
22	286	238	204	178	158	143	130	119
24	312	260	223	195	173	156	141	130

The following table is calculated for factories situated in the Northern States—the column marked "Spindles," shows the number of spindles in the factory with looms, the column marked "Tons," shows the number of tons of Anthracite Coal consumed per year. The factories are supposed to be heated by steam.

Example.

Required, the number of tons of Anthracite Coal per year to heat a factory containing 2000 spindles with looms—find

2000 in the column marked "Spindles," opposite to this number in the column marked "Tons," will be found 32 tons; this includes the coal required for making starch, and heating the dressing room.—*Answer.*

EXAMPLE.

Required, the number of tons of Anthracite Coal per year to heat a factory containing 8000 spindles with looms—find 8000 in the column marked "Spindles," opposite to this number in the column marked "Tons," will be found 128 tons.—*Answer.*

No. 14.

Spindles	Tons.
1000	16
2000	32
3000	48
4000	64
5000	80
6000	96
7000	112
8000	128
9000	144
10000	160

The following table shows the number of cubic feet in the plain cylindrical return flue boiler required to heat factories containing different number of spindles with looms. This table is predicated from those factories which consume the least amount of coal for a given number of spindles; the column marked "Spindles," shows the number of spindles with looms which the factories contain.

EXAMPLE.

A boiler is 3 feet in diameter and 13 feet long, the contents in cubic feet is 92, nearly what size factory will this boiler heat—find 92, or the nearest number to it in the column marked "Contents," opposite to this number in the

column marked "Spindles," will be found 2000 spindles with looms.—*Answer.*

EXAMPLE.

Required, the contents of a boiler to heat a factory containing 4000 spindles with looms—find 4000 in the column marked "Spindles," opposite to this number in the column marked "Contents," will be found 184 cubic feet: if the diameter of this boiler was 2 feet, what would be the length, the area of the end of a boiler 2 feet in diameter is 3 feet nearly, divide 184 by 3, gives $61\frac{1}{3}$ feet, the length of the boiler, or two boilers say 30 feet each, and 2 feet in diameter.—*Answer.*

No. 15.

Spindles	Contents.
1000	46
2000	92
3000	138
4000	184
5000	230
6000	276
7000	322
8000	368
9000	414
10000	460

The following table shows the number of operatives required to operate different number of spindles, on different numbers of yarn with looms: this table is predicated from the statements in the Note (I.)—the column marked "Spindles," shows the number of spindles to be operated with looms, the column marked "No. of Yarn," shows the number of the yarn.

EXAMPLE.

Required, the number of operatives to operate 6000 spindles the number of the yarn being 35—find 6000 in the

column marked "Spindles," opposite to this number in the table, and under 35 in the column marked "No. of Yarn," will be found 162 operatives, the number required to operate 6000 mule and frame spindles with looms on No. 35 yarn. —*Answer.*

EXAMPLE.

Required, the number of operatives to operate 10000 spindles, the number of the yarn being 15—find 10000 in the column marked "Spindles," opposite to this number in the table, and under 15 in the column marked "No. of Yarn," will be found 330 operatives.—*Answer.*

No. 16.

Spindls.	No. 5.	No. 10	No. 15.	No. 20.	No. 25.	No. 30.	No. 35.	No. 40.
1000	36	35	33	32	30	29	27	26
2000	72	69	66	63	60	57	54	52
3000	108	103	99	94	90	85	81	78
4000	144	138	132	126	120	114	108	104
5000	180	172	165	157	150	142	135	130
6000	216	207	198	189	180	171	162	156
7000	252	241	231	220	210	199	189	182
8000	288	276	264	252	240	228	216	208
9000	324	310	297	283	270	256	243	234
10000	360	345	330	315	300	285	270	260

The following tables show the amount paid for labor per week, to operate different number of spindles with looms; and the amount paid per week, including all expenses except the cost of cotton, to operate different number of spindles with looms on different number of yarn.

EXAMPLE.

Required, the amount paid per week including all expenses except the cost of cotton, to operate 4000 spindles with looms on No. 30 yarn—find 4000 in the column marked "Spindles," opposite to this number in the table, and under "No. 30," will be found 556 dollars.—*Answer.*

EXAMPLE.

Required, the amount paid per week for labor, to operate 2000 mule and frame spindles on No. 30 yarn with looms—find 2000 in the column marked "Spindles," opposite to this number in the table, and under "No. 30," will be found 204 dollars.—*Answer.*

No. 17.

AMOUNT PAID PER WEEK, INCLUDING ALL EXPENSES EXCEPT THE COST OF COTTON.

Spindls.	No. 5.	No. 10.	No. 15.	No. 20.	No 25.	No. 30.	No. 35.	No. 40.
1000	174	167	160	153	146	139	132	124
2000	348	334	320	306	292	278	264	249
3000	522	501	480	459	438	417	396	373
4000	696	668	640	612	584	556	528	498
5000	870	835	800	765	730	695	660	622
6000	1044	1002	960	918	876	834	792	747
7000	1218	1169	1120	1071	1022	973	924	871
8000	1392	1336	1280	1224	1168	1112	1056	996
9000	1566	1503	1440	1377	1314	1251	1188	1120
10000	1740	1670	1600	1530	1460	1390	1320	1245

AMOUNT PAID TO OPERATIVES PER WEEK.

Spindls.	No. 5.	No. 10.	No. 15.	No. 20.	No. 25.	No. 30.	No. 35.	No. 40.
1000	130	124	119	113	108	102	96	91
2000	260	248	238	226	216	204	192	182
3000	390	372	357	339	324	306	288	273
4000	520	496	476	452	432	408	384	364
5000	650	620	595	565	540	510	480	455
6000	780	744	714	678	648	612	576	546
7000	910	868	833	791	756	714	672	637
8000	1040	992	952	904	864	816	768	728
9000	1170	1116	1071	1017	972	918	864	819
10000	1300	1240	1190	1130	1080	1020	960	910

The following table shows the cost per pound, for manufacturing different numbers of yarn from different prices of cotton—the column marked "No. Yarn," shows the number of yarn, the column marked "Hanks," shows the

number of hanks per spindle the frames are supposed to turn off per day, the column marked "Price of Cotton," shows the range of the cost of the same quality of cotton; this table is calculated for a mill of 2000 frame spindles, either the cap frame, or the dead spindle frame, or the ring and traveler frame. (See Note H.)

No. 18.

No. Yarn	PRICE OF COTTON.											
Hanks.	6	6¼	7	7¼	8	8¼	9	9¼	10	10¼	11	
12	6.00	10.55	11.15	11.73	12.33	12.92	13.51	14.11	14.71	15.31	15.90	16.50
14	5.83	11.16	11.76	12.36	12.96	13.56	14.16	14.76	15.36	15.96	16.56	17.16
16	5.63	11.86	12.45	13.04	13.63	14.22	14.81	15.40	15.99	16.58	17.17	17.76
18	5.49	12.52	13.11	13.70	14.29	14.88	15.48	16.07	16.66	17.25	17.84	18.43
20	5.32	13.20	13.81	14.41	15.02	15.62	16.23	16.84	17.41	18.01	18.62	19.21
22	5.15	13.88	14.48	15.08	15.67	16.26	16.88	17.48	18.07	18.66	19.28	19.88
24	4.98	14.56	15.10	15.71	16.31	16.91	17.52	18.12	18.72	19.31	19.92	20.51
26	4.81	15.24	15.81	16.42	17.03	17.62	18.22	18.82	19.42	20.02	20.62	21.22
28	4.64	15.92	16.51	17.12	17.71	18.30	18.92	19.51	20.12	20.72	21.32	21.92
30	4.47	16.60	17.20	17.81	18.41	19.02	19.61	20.21	20.81	21.41	22.03	22.62
32	4.30	17.28	17.88	18.46	19.08	19.61	20.38	20.88	21.48	22.08	22.66	23.28
34	4.13	17.96	18.56	19.14	19.74	20.34	20.94	21.54	22.14	22.74	23.34	23.94
36	3.96	18.64	19.24	19.82	20.43	21.04	21.64	22.24	22.86	23.44	24.04	24.64
38	3.79	19 32	19.94	20.54	21.14	21.74	22.34	22.94	23.54	24.14	24.74	25.34
40	3.62	20.04	20.64	21.23	21.84	22.43	23.04	23.62	24.22	24.82	25.44	26.03

EXAMPLE.

Required, the cost per pound to make number 20 twist, when the cotton is worth 10 cents—find 20 in the column marked "No. of Yarn," opposite to this number in the table, and under 10 in the column marked "Price of Cotton," will be found 18.01 cents per pound.—*Answer.*

EXAMPLE.

Required, the cost per pound to make No. 28 twist, when cotton is worth 8½ cents—find 28 in the column marked "No. Yarn," opposite to this number in the table, and under 8½ in the column marked "Price of Cotton," will be found 18.92 cents per pound.

The following tables show the cost per yard for manufacturing different styles of goods—the column marked

[No. 19.

Width	No. Yarn	Filling	Warp	Wt.	PRICE OF COTTON.									
					6	6¼	7	7¼	8	8¼	9	9¼	10	10¼	11
4-4	14	40	42	3.00	5.26	5.50	5.74	5.98	6.22	6.46	6.70	6.94	7.18	7.42	7.66
"	14	44	44	2.90	5.95	6.20	6.45	6.70	6.95	7.20	7.45	7.70	7.95	8.20	8.45
"	18	48	46	3.40	5.68	5.88	6.08	6.27	6.46	6.68	6.87	7.08	7.26	7.48	7.68
"	22	54	50	3.80	5.55	5.76	5.97	6.18	6.39	6.60	6.81	7.02	7.23	7.44	7.65
"	25	58	54	4.00	5.78	5.87	5.96	6.05	6.14	6.23	6.32	6.41	6.50	6.59	6.68
"	28	64	60	4.10	6.00	6.16	6.32	6.48	6.64	6.80	6.96	7.12	7.28	7.44	7.60
"	30	68	64	4.20	6.28	6.43	6.58	6.73	6.88	7.03	7.18	7.33	7.48	7.63	7.78
"	33	72	68	4.20	6.71	6.85	6.99	7.13	7.27	7.41	7.55	7.69	7.83	7.93	8.11
"	36	76	72	4.40	6.80	6.93	7.06	7.19	7.32	7.45	7.58	7.71	7.84	7.97	8.10
"	40	80	76	4.25	7.46	7.59	7.72	7.85	7.98	8.11	8.24	8.37	8.50	8.63	8.76

"Width," shows the width of the goods, the column marked "No. Yarn," shows the number of the yarn, the columns marked "Filling and Warp," shows the number of picks or threads per inch in the filling and warp, the column marked "Weight," shows the number of yards per pound, the column marked "Price of Cotton," shows the price of the cotton. Two statements are given in Note (I) in order to show the data from which these tables were calculated.

No. 20.

					PRICE OF COTTON.										
Wdth	No. Yarn	Filng	Warp	Wt.	6	6½	7	7½	8	8½	9	9½	10	10½	11
7-8	14	40	42	3.4	4.64	4.82	5.00	5.18	5.36	5.54	5.72	5.89	6.07	6.25	6.43
"	14	44	44	3.3	5.32	5.50	5.68	5.86	6.04	6.22	6.40	6.58	6.74	6.92	7.10
"	18	48	46	3.9	4.95	5.10	5.25	5 40	5.55	5.70	5.85	6.00	6.15	6.30	6.45
"	22	54	50	4.3	4.90	5.04	5.18	5.32	5.46	5.60	5.74	5.88	6.02	6.16	6.30
"	25	58	54	4.6	5.18	5.37	5.18	5.27	5.36	5.45	5.54	5.63	5.72	5.81	5.90
"	28	64	60	4.7	5.24	5.36	5.48	5.60	5.72	5.84	5.96	6 08	6.20	6.32	6.44
"	30	68	64	4.8	5.50	5.61	5.72	5.83	5.94	6.05	6.16	6.27	6.38	6.49	6.60
"	33	72	68	4.8	5.87	5.98	6.09	6.20	6.31	6.42	6.53	6.64	6.75	6.86	6.97
"	36	76	72	5.0	6.00	6.10	6.22	6.32	6.42	6.53	6.65	6.74	6.85	6.94	7.04
"	40	80	76	4.8	6.60	6.74	6.86	7.02	7.16	7.21	7.34	7.46	7.58	7.68	7.83

EXAMPLE.

The number of the yarn being 31, the number of picks in the filling and warp being 64 and 60 per inch, the weight of the goods being 5.8 yards per pound, the width of the goods being $\frac{3}{4}$, and the cost of the cotton being 8 cents, required, the cost per yard—find 31 in the column marked "No. Yarn," opposite to this number in the table, and under 8 in the column marked "Price of Cotton," will be found 4.68 cents per yard, the total cost of manufacturing.—*Answer.*

No. 21.

Width	No. Yarn	Filing	Warp	Wt.	PRICE OF COTTON.										
					6	6½	7	7½	8	8½	9	9½	10	10½	11
3-4	14	40	42	4.0	3.93	4.10	4.27	4.44	4.61	4.78	4.95	5.12	5.29	5.46	5.63
"	14	44	44	3.8	4.61	4.78	4.95	5.12	5.29	5.46	5.63	5.80	5.97	6.14	6.31
"	18	48	46	4.5	4.29	4.43	4.57	4.71	4.85	4.99	5.13	5.27	5.41	5.55	5.69
"	24	54	50	5.3	3.97	4.08	4.19	4.30	4.41	4.52	4.63	4.74	4.85	4.96	5.07
"	28	58	54	5.8	3.94	4.04	4.14	4.26	4.37	4.45	4.54	4.63	4.73	4.82	4.96
"	31	64	60	5.8	4.24	4.35	4.46	4.57	4.68	4.79	4.90	5.01	5.12	5.23	5.34
"	33	68	64	5.8	4.55	4.65	4.75	4.85	4.94	5.05	5.14	5.24	5.34	5.43	5.55
"	36	72	68	5.9	4.77	4.88	4.99	5.10	5.21	5.32	5.43	5.54	5.65	5.76	5.87
"	38	76	72	5.9	5.07	5.17	5.27	5.36	5.43	5.54	5.63	5.74	5.86	5.97	6.07
"	40	80	76	5.9	5.37	5.49	5.61	5.73	5.85	5.97	6.09	6.22	6.34	6.46	6.58

The following table shows the number of revolutions of the front roller per minute on different kinds of spinning machines—the column marked "No. Yarn," shows the number of the yarn, the columns marked "Cap, Dead, Ring, Live, and Mule Spindles," shows the different kinds of spinning.

EXAMPLE.

Required, the number of revolutions per minute of the front roller on the cap frame to spin No. 20 yarn—find 20 in the column marked "No. Yarn," opposite to this number in the column marked "Cap Spindles," will be found 100 revolutions.—*Answer.*

EXAMPLE.

Required, the number of "Stretches" a self-operating mule will make per minute on No. 35 yarn—find 35 in the column marked "No. Yarn," opposite to the number in the column marked "Mule Spindles," will be found $2\frac{3}{4}$ stretches.—*Answer.*

No. 22.

No. Yarn.	Cap Spindles	Dead Spindles	Ring Spindles	Live Spindles	Mule Spindles
5		100		80	3
10		90		75	3
15	110	85	85	70	3
20	100	80	80	68	3
25	96	78	78	65	3
30	90	75	75	62	$2\frac{7}{8}$
35		72	72	60	$2\frac{3}{4}$
40		68	68	56	$2\frac{5}{8}$

The following table shows the range of drafts and doublings, which are preferred by different manufacturers.

EXAMPLE.

Required, the range of draft that a card may have—find "Card," in the column marked machine, opposite, in the

column marked "Draft," will be found 40 to 80 draft, this shows that some manufacturers draw 40 to 1, while others draw 80 to 1.—*Answer.*

EXAMPLE.

Required, the range of doublings on the drawing frame —find "Drawing," in the column marked "Machines," opposite in the column marked "Doublings," will be found 64 to 212 doublings.—*Answer.*

No. 23.

Machines.	Drafts.	Doublings.
Picker	1 to 2	1 to 3
Card	40 to 80	40 to 60
R. R. Head	2 to 5	4 to 10
	Each Head	Three Heads
Drawing	4 to 8	64 to 216
Speeder	5 to 8	" "
Fine Ditto	6 to 8	1 to 2
Mule Filling	8 to 11	" "
Frame Warp	7 to 9	" "

The column in the following table marked "Revolutions," shows the number of revolutions of the front roller per minute, the column marked "Hours," shows that the frame is calculated to run 12 hours without stopping, the column marked "Skeins," shows the number of skeins which the frame will turn off.

No. 24.

Revolus.	Skeins.	Hours.	Revolus.	Skeins.	Hours.
50	3.5	12	90	6.3	12
55	3.8	12	95	6 6	12
60	4.2	12	100	7.0	12
65	4.5	12	105	7.3	12
70	4.9	12	110	7.7	12
75	5.2	12	115	8.0	12
80	5.6	12	120	8.4	12
85	5.9	12	125	8.7	12

EXAMPLE.

Required, the number of skeins that a frame will turn off in 12 hours, the front roller making 80 turns per minute—find 80 in the column marked "Revolutions," opposite to this number in the column marked "Skeins," will be found 5.6 skeins.—*Answer.*

The following table shows the twist required per inch for different numbers of yarn—the column marked "No. Yarn," shows the number of the yarn, the column marked "Filling," shows the twist required per inch for filling, the column marked "Warp," shows the twist per inch required for warp.

EXAMPLE.

Required, the twist per inch for No. 20 filling—find 20 in the column marked "No. Yarn," opposite to this number in the column marked "Filling," will be found 16 turns per inch, the twist required.—*Answer.*

EXAMPLE.

Required, the twist per inch for No. 20 warp—find 20 in the column marked "No. Yarn," opposite to this number in the column marked "Warp," will be found 19 turns per inch, the twist required.—*Answer.*

No. 25.

No. Yrn.	Filling.	Warp.	No. Yrn.	Filling.	Warp.
5	8	9.5	25	18	21
8	10	12	28	20	23
10	11	14	30	21	25
14	13	16	33	23	26
16	14	17	36	24	28
18	15	18	38	25	29
20	16	19	40	27	30
22	17	20			

The following table shows the twist required for different numbers of roving.

EXAMPLE.

Required, the twist per inch for No. 4 roving—find 4 in the column marked "No. Roving," opposite to this number in the column marked "Twist," will be found 2 turns per inch.—*Answer.*

EXAMPLE.

Required, the twist per inch for No. $2\frac{1}{2}$ roving—find 2.5 in the column marked "No. Roving," opposite to this number in the column marked "Twist," will be found 1.6 twist per inch.—*Answer.*

The twist required for different No. of yarn and roving represented in these tables, has been collected from some of the best operating factories in the country.

No. 26.

No. Rvg	Twist.	No. Rvg	Twist.
0.1	1.0	4.0	2.0
1.5	1.2	4.5	2.1
2.0	1.4	5.0	2.2
2.5	1.6	6.0	2.5
3.0	1.7	7.0	2.7
3.5	1.9		

The following table shows the number of yards a loom would turn off per day (in 12 hours) if the loom did not stop during the 12 hours or day. The column marked "Picks," shows the number of picks the loom runs per minute, the column marked "Thread," shows the number of thread or picks of filling per inch, the column marked "Yards," shows the number of yards the loom would turn off in 12 hours.

EXAMPLE.

Required, the number of yards turned off per day, the number of picks per inch in the filling being 72—find 72 in the column marked "Threads," opposite to this number in the column marked "Yards," will be found 31 yards.—*Answer.*

EXAMPLE.

Required, the number of yards turned off per day, the number of picks per inch in the filling being 64—find 64 in the column marked "Threads," opposite to this number in the column marked "Yards," will be found 35 yards.—*Answer.*

No. 27.

Picks.	Threads.	Yards.	Hours.
112	30	74	12
"	38	59	12
"	40	56	12
"	44	50	12
"	50	45	12
"	56	40	12
"	60	37	12
"	64	34	12
"	68	32	12
"	72	30	12
"	76	29	12
"	80	28	12

Several lots of different qualities of cotton were run through the pickers and cards and the per cent waste noted. From these experiments, together with the information obtained from the factories working the different qualities of cotton, the following table is predicated. The column marked "Price," shows the price of the cotton, that is, when the best quality of short staple cotton is worth 10 cents per pound, the poorest quality will be worth $7\frac{1}{2}$ cents per pound.

EXAMPLE.

Required, the per cent loss of the poorest quality of short staple cotton when spun into yarn—find $7\frac{1}{2}$ in the column marked "Price," opposite to this number in the column marked "Per Cent," will be found 15 per cent loss.—*Answer.*

EXAMPLE.

When the best quality of short staple cotton is worth 10 cents per pound, what per cent loss will there be in a quality which is worth 8_2 cents—find $8\frac{1}{2}$ in the column marked "Price," opposite to this number in the column marked "Per Cent," will be found $12\frac{1}{2}$ per cent waste.—*Answer.*

No. 28.

Per Cent	Price.
10	10
$10\frac{1}{2}$	$9\frac{1}{2}$
$11\frac{1}{4}$	9
$12\frac{1}{2}$	$8\frac{1}{2}$
$13\frac{3}{4}$	8
15	$7\frac{1}{2}$

The following table shows the number of gallons of oil required for different number of spindles per day, (for machinery only,)—the column marked "Gallons," shows the number of gallons required per day, the column marked "Spindles," shows the number of spindles.

EXAMPLE.

A factory contains 6000 spindles with looms; required, the number of gallons of oil to supply the factory per day—find 6000 in the column marked "Spindles," opposite to this number in the column marked "Gallons," will be found 4 gallons.—*Answer.*

EXAMPLE.

Required, the number of gallons of oil to supply a factory of 2000 spindles with looms for 100 days—find 2000 in the column marked "Spindles," opposite to this number in the column marked "Gallons," will be found $1\frac{1}{4}$ gallons, which multiplied by 100 gives 125 gallons.—*Answer.*

No. 29.

Spindles	Gallons.
1000	$\frac{3}{4}$
2000	$1\frac{1}{4}$
3000	2
4000	$2\frac{1}{2}$
5000	$3\frac{1}{4}$
6000	4
7000	$4\frac{1}{2}$
8000	$5\frac{1}{4}$
9000	$5\frac{3}{4}$
10000	$6\frac{1}{2}$

The following table shows the number of revolutions per minute of the front roller on different kinds of roving frames —the column marked "No. Roving," shows the number of roving.

EXAMPLE.

Required, the number of revolutions per minute of the front roller on the non-twisting or condensing speeder making No. 2 roving—find 2 in the column marked "No. Roving," opposite to this number in the column marked "Non-twisting Speeder," will be found 450 revolutions per minute.—*Answer.*

EXAMPLE.

Required, the number of revolutions of the front roller per minute on the twisting speeder on No. 4 roving—find 4 in the column marked "No. Roving," opposite to this num-

ber in the column marked "Twisting Speeders," will be found 165 revolutions.—*Answer.*

EXAMPLE.

Required, the number of revolutions of the front roller per minute on the fly frame on No. 4 roving—find 4 in the column marked "No. Roving," opposite to this number in the column marked "Fly Frame," will be found 118 revolutions.—*Answer.*

No. 30.

No. Roving.	Non-twistg Speeders.	Twistng Speeders	Fly Frame.
1	450	200	140
1½	"	190	135
2	"	185	130
2½	"	180	128
3	"	175	125
3½		170	120
4		165	118
4½		160	116

The following tables show the usual amount of yarn turned off per day by the different kinds of spinning.

EXAMPLE.

Required, the number of pounds of No. 8 yarn that 2000 dead spindles will turn off per day—find 8 in the column marked "No. Yarn," opposite to this number in the table, and under 2000 in the column marked "No. Spindles," will be found 1236 pounds, the amount turned off per day.—*Answer.*

EXAMPLE.

Required, the number of pounds of No. 36 yarn that 3000 mule spindles will turn off per day—find 36 in the column marked "No. Yarn," opposite to this number in the table,

and under 3000 in the column marked "No. Spindles," will be found 270 pounds.—*Answer.*

No. 31.

No. Spindles. Live Spindle Frames.

No. Yarn.	500	1000	1500	2000	2500	3000	3500	4000
5	450	900	1350	1800	2250	2700	3150	3600
8	278	556	834	1112	1390	1668	1946	2224
10	219	438	657	876	1095	1314	1533	1752
12	178	356	534	712	890	1068	1246	1424
14	151	302	453	604	755	906	1057	1208
16	129	258	387	516	645	774	903	1032
18	113	226	339	452	565	678	791	904
20	101	202	303	404	505	606	707	808
22	90	180	270	360	450	540	630	720
25	79	158	237	316	395	474	553	632
28	69	138	207	276	345	414	483	552
30	63	126	189	252	315	378	441	504
33	56	112	168	224	280	336	392	448
36	51	102	153	204	255	306	357	408
40	45	90	135	180	225	270	315	360

No. 32.

No. Spindles. Mules.

No Yarn.	500	1000	1500	2000	2500	3000	3500	4000
5	400	800	1200	1600	2000	2400	2800	3200
8	247	494	741	988	1235	1482	1729	1976
10	195	390	585	780	975	1170	1365	1560
12	158	316	474	632	790	948	1106	1264
14	134	268	402	536	670	804	938	1072
16	115	230	345	460	575	690	805	920
18	101	202	303	404	505	606	707	808
20	90	180	270	360	450	540	630	720
22	80	160	240	320	400	480	560	640
25	70	140	210	280	350	420	490	560
28	61	122	183	244	305	366	427	488
30	56	112	168	224	280	336	392	448
33	50	100	150	200	250	300	350	400
36	45	90	135	180	225	270	315	360
40	40	80	120	160	200	240	280	320

Example.

Required, the number of pounds of No. 16 yarn that 2000 cap spindles will turn off per day—find 16 in the col-

umn marked "No. Yarn," opposite to this number in the table, and under 2000 in the column marked "No. Spindles," will be found 848 pounds.—*Answer.*

No. 33.

No. Spindles. Cap, or Danforth's Frame.

No. Yarn.	500	1000	1500	2000	2500	3000	3500	4000
14	250	500	750	1000	1250	1500	1750	2000
16	212	424	636	848	1060	1272	1484	1696
18	183	366	549	732	915	1098	1281	1464
20	160	320	480	640	800	960	1120	1280
22	141	282	423	564	705	846	987	1128
25	120	240	360	480	600	720	840	960
28	103	206	309	412	515	618	721	824
30	93	186	279	372	465	558	651	744

No. 34.

No. Spindles. Dead Spindle Frame.

No. Yarn.	500	1000	1500	2000	2500	3000	3500	4000
5	500	1000	1500	2000	2500	3000	3500	4000
8	309	618	927	1236	1545	1854	2163	2472
10	244	488	732	976	1220	1464	1708	1952
12	197	394	591	788	985	1182	1379	1576
14	167	334	501	668	835	1002	1169	1336
16	144	288	432	576	720	864	1008	1152
18	126	252	378	504	630	756	882	1008
20	112	224	336	448	560	672	784	896
22	100	200	300	400	500	600	700	800
25	88	176	264	352	440	528	616	704
28	76	152	228	304	380	456	532	608
30	70	140	210	280	350	420	490	560
33	62	124	186	248	310	372	434	496
36	56	112	168	224	280	336	392	448
40	50	100	150	200	250	300	350	400

Example.

Required, the amount of No. 25 yarn that 4000 ring spindles will turn off per day—find 25 in the column marked "No. Yarn," opposite to this number in the table, and under 4000 in the column marked "No. Spindles," will be found 704 pounds.—*Answer.*

No. 35.

No. Spindles. Ring Spindle Frames.

No. Yarn.	500	1000	1500	2000	2500	3000	3500	4000
14	167	334	501	668	835	1002	1169	1336
16	144	288	432	576	720	864	1008	1152
18	126	252	378	504	630	756	882	1008
20	112	224	336	448	560	672	784	896
22	100	200	300	400	500	600	700	800
25	88	176	264	352	440	528	616	704
28	76	152	228	304	380	456	532	608
33	70	140	210	280	350	420	490	560
30	62	124	186	248	310	372	434	496
36	56	112	168	224	280	336	392	448

Example.

Required, the amount of No. 30 yarn that 2000 live spindles will turn off per day—find 30 in the column marked "No. Yarn," opposite to this number in the table, and under 2000 in the column marked "No. Spindles," will be found 252 pounds.—*Answer.*

The following table shows the usual number of pounds that $\frac{3}{4}$ yard wide looms will weave per day on different numbers of yarn. A $\frac{7}{8}$ loom will turn off $1\frac{1}{6}$, and a $\frac{4}{4}$ loom $1\frac{1}{2}$ more than a $\frac{3}{4}$ loom per day: the column marked "Threads," shows the number of threads or "Picks" in the filling per inch, the column marked "No. of Looms," shows the number of looms required to produce the amount in the table.

Example.

Required, the number of pounds of goods that 50 looms will weave per day, the number of picks in the filling per inch being 64—find 64 in the column marked "Threads," opposite to this number in the table, and under 50 in the column marked "Looms," will be found 250 pounds.—*Answer.*

If they were $\frac{7}{8}$ looms the production would be $\frac{250}{16}$, which gives 16 pounds nearly, which added to 250 gives 266 pounds. If they were $\frac{4}{4}$ looms the production would be $\frac{250}{12}$, which gives 21 pounds nearly, which added to 250 gives 271 pounds.

EXAMPLE.

Required, the number of pounds of goods that 30 looms will weave per day, the number of picks in the filling per inch being 30—find 30 in the column marked "Threads," opposite to this number in the table, and under 30 in the column marked "Looms," will be found 750 pounds.—*Answer.*

No. 36.

No. of Looms on $\frac{3}{4}$ Goods.

Thrds	20	30	40	50	60	70	80	90	100
30	500	750	1000	1250	1500	1750	2000	2250	2500
38	280	420	560	700	840	980	1120	1260	1400
40	200	300	400	500	600	700	800	900	100
44	180	270	360	450	540	630	720	810	900
50	140	210	280	350	420	490	560	630	700
56	120	180	240	300	360	420	480	540	600
50	112	168	224	280	336	392	448	504	560
64	100	150	200	250	300	350	400	450	500
68	94	141	188	235	282	329	376	423	470
72	90	135	180	225	270	315	360	405	450
76	80	120	160	200	240	280	320	360	400
80	70	105	140	175	210	245	280	315	350

The following table shows the usual number of picks per minute of looms weaving different width of goods and different numbers of yarn; the column marked "No. Yarn," shows the number of the yarn, the column marked "Width," shows the width of the goods.

EXAMPLE.

Required the number of picks per minute of a $\frac{3}{4}$ loom, weaving No. 25 yarn—find 25 in the column marked "No.

Yarn," opposite to this number in the table, and under $\frac{3}{4}$ in the column marked "Width," will be found 112 picks per minute.—*Answer.*

EXAMPLE.

Required, the number of picks per minute of a $\frac{4}{4}$ loom, weaving No. 10 yarn—find 10 in the column marked "No. Yarn," opposite to this number in the table, and under $\frac{4}{4}$ in the column marked "Width," will be found 112 picks per minute.—*Answer.*

No. 37.

No. Yarn.	WIDTH. 3-4	7-8	4-4
5	110	98	96
10	108	106	104
15	118	116	114
20	114	112	110
25	112	110	108
30	112	110	108
36	110	108	106

Note H.

The tables showing the cost per pound for manufacturing different No. of yarn from different prices of cotton, was predicated from the following estimates. An estimate showing the cost per pound for manufacturing No. 12 twist or warp yarn, the price of the cotton being 6 cents per pound. The factory is supposed to contain 2000 frame spindles; the cap or Danforth frame, or the dead spindle frame, or the ring and traveler frame; as it is found by a very accurate calculation, that the cost per pound for manufacturing on these frames does not differ materially. The cost of manufacturing on the live spindle frame is found by a calculation predi-

cated upon actual results, to exceed the cost of manufacturing on the foregoing frames about 7 per cent per pound.

2 Picker Tenders	$3.00	per week each	$6.00	
2 Card Strippers	2.50	"	5.00	
6 Drawing Tenders	2.50	"	15.00	
1 Speeder Tender	3.00	"	3.00	
2 Fine do. Tenders	3.00	"	6.00	
1 Sweeper	2.00	"	2.00	
1 Card Grinder	5.00	"	5.00	
1 Overseer	8.00	"	8.00	
				50.00
12 Frame Piecers	2.50	"	30.00	
4 Ditto Doffers	2.50	"	10.00	
6 Reel Tenders	2.50	"	15.00	
1 Second Overseer	3.00	"	3.00	
1 Overseer	8.00	"	8.00	
				66.00
1 Yarn Bundler	3.00	"	3.00	
1 Ditto Baler	4.00	"	4.00	
1 Ditto Repairer	6.00	"	6.00	
1 Watchman	7.00	"	7.00	
1 Clerk	8.00	"	8.00	
1 Manager	15.00	"	15.00	
				43.00
Insurance . . .		say	10.00	
Fires		"	4.00	
Oil		"	12.00	
Freight and Cartage . .		"	15.00	
Ordinary Repairs . .		"	10.00	
7058 Pounds of Cotton, (15 per cent waste gives 6000 Pounds of Yarn the production per week) at 6 cents per pound gives			423.00	
				474.00
				$633.00

6000)633.00

10.55 cents the cost per pound.

It will be observed that all ordinary expenses are included in this estimate except commission and cost of power. The value of the waste, which amounts to about 20 dollars per week, will probably fully cancel those small incidental expenses which have not appeared in detail in the estimate.

An estimate showing the cost per pound for manufacturing No. 40 twist or warp yarn, the price of the cotton being 6 cents per pound.

1 Picker Tender	$3.00	per week each	$3.00	
1 Card Stripper	4.00	"	4.00	
1 Lap double Tender	2.00	"	2.00	
2 Drawing Tenders	2.50	"	5.00	
1 Speeder Tender	2.00	"	2.00	
1 Fine do. Tender	3.00	"	3.00	
1 Sweeper	2.00	"	2.00	
1 Second Overseer	5.00	"	5.00	
1 Overseer	8.00	"	8.00	
				34.00
9 Frame Piecers	2.50	"	22.50	
2 Ditto Doffers	2.50	"	5.00	
4 Reel Tenders	2.50	"	10.00	
1 Second Overseer	3.00	"	3.00	
1 Overseer	8.00	"	8.00	
				48.50
1 Yarn Baler	4.00	"	4.00	
1 Repairer	6.00	"	6.00	
1 Watchman	7.00	"	7.00	
1 Clerk	6.00	"	6.00	
1 Manager	15.00	"	15.00	
				38.00
Insurance		say	6.00	
Fires		"	3.00	
Oil		"	6.75	
Freight and Cartage . .		"	5.00	
Ordinary Repairs . . .		"	8.00	

1230 Pounds of Cotton (12 per cent waste gives 1063 pounds of yarn the production per week,) at 6 cents per pound gives	63.78
	92.53
	$ 213.03

1062)213.03

20.04 cents cost per pound.

Note I.

An estimate showing the cost per yard for manufacturing yard-wide goods, the yarn being No. 14; the number of threads per inch in the warp being 42; the number of threads per inch in the filling being 40; the weight of the goods being three yards per pound; and the price of the cotton being 6 cents per pound. The factory is supposed to contain 2000 spindles, 1111 mule spindles, producing 4 hanks per spindle per day, and 889 frame spindles, producing 5 hanks per spindle per day, and 56 yard-wide looms.

2 Picker Tenders	$2.50	per week each	$5.00	
2 Card Strippers	2.50	"	5.00	
6 Drawing Tenders	2.00	"	12.00	
1 Speeder Tender	2.50	"	2.50	
2 Fine do. Tenders	2.50	"	5.00	
1 Sweeper	2.00	"	2.00	
1 Card Grinder	4.00	"	4.00	
1 Overseer	8.00	"	8.00	
				43.50
5 Frame Piecers	2.50	"	12.50	
2 Frame Doffers	2.00	"	4.00	
2 Mule Piecers	2.50	"	5.00	
2 Ditto	2.00	"	4.00	
2 Ditto	1.50	"	3.00	
1 Mule Doffer	2.50	"	2.50	

2 Spooler Tenders	2.50	"	5.00	
1 Warper Tender	3.00	"	3.00	
2 Dresser Tenders.	7.00	"	14.00	
1 Overseer	8.00	"	8.00	
				61.00
370 Cuts at 18 cts. (one extra Weaver at 3.40)			70.00	
2 Reeders	2.50	"	5.00	
2 Cloth Trimmers	2.50	"	5.00	
1 Cloth Baler	3.00	"	3.00	
1 Overseer	8.00	"	8.00	
				91.00
1 Repairer	8.00	"	8.00	
1 Watchman	7.00	"	7.00	
1 Clerk	8.00	"	8.00	
1 Manager	20.00	"	20.00	
				43.00
Insurance		say	15.00	
Fires		"	5.00	
Oil		"	15.00	
Freight and Cartage . . .		"	12.00	
Ordinary Repairs . . .		"	16.00	
Shuttles, Harnesses, Reeds, Starch, &c.		"	19.00	
4608 Pounds of Cotton (18 per cent waste gives 3779 pounds of yarn, or 11337 yards of goods per week; the production of 2000 spindles, and 56 looms per week,) at 6 cents per pound gives			276.48	
				358.48
				$ 596.98

11337)596.98

5.26 cents per yard.

An estimate showing the cost per yard to manufacture yard-wide goods the number of the yarn being 40; the number of thread per inch in the filling being 80; the number of

threads in the warp being 76 per inch; and the weight of the goods being 4.25 yards per pound. The factory is supposed to contain 2000 spindles, 1037 mule spindles producing $3\frac{1}{4}$ hanks per spindle, per day; and 963 frame spindles producing $3\frac{1}{2}$ hanks per spindle, per day; 50 yard-wide looms; the price of the cotton being 6 cents per pound.

1 Picker Tender	$3.00	per week each	$3.00	
1 Card Stripper	3.00	"	3.00	
1 Lap doubler Tender	2.00	"	2.00	
2 Drawing Tenders	2.00	"	4.00	
1 Speeder Tender	2.00	"	2.00	
1 Fine do. Tender	2.50	"	2.50	
1 Overseer	8.00	"	8.00	
				24.50
2 Mule Piecers	2.50	"	5.00	
2 Ditto	2.00	"	4.00	
2 Ditto	1.50	"	3.00	
4 Frame Piecers	2.50	"	10.00	
2 Frame Doffers	2.00	"	4.00	
2 Spooler Tenders	2.50	"	5.00	
1 Warper Tender	2.50	"	2.50	
2 Dresser Tenders	7.00 & 3.00	"	10.00	
1 Overseer	8.00	"	8.00	
				51.50
17 Weavers	3.50	"	59.50	
2 Reeders	2.00	"	4.00	
1 Cloth Trimmer	2.50	"	2.50	
1 Cloth Baler	3.00	"	3.00	
1 Overseer	8.00	"	8.00	
				77.00
1 Repairer	6.00	"	6.00	
1 Watchman	7.00	"	7.00	
1 Clerk	6.00	"	6.00	
1 Manager	15.00	"	15.90	
				34.00

Insurance	say	12.00	
Fires	"	4.00	
Oil	"	12.00	
Freight and Cartage . . .	"	8.00	
Ordinary Repairs . . .	"	12.00	
Shuttles, Harnesses, Reeds, Starch, &c.	"	14.00	
1188 Pounds of Cotton (15 per cent waste gives 1010 pounds of yarn, or 4292 yards the production per week of 2000 spindles) at 6 cents per pound gives . .		71.28	
			133.28
			$ 320.28

4292)320.28

7.46 cents cost per yard.

On this style of goods a weaver will turn off nearly as many yards per day on two looms as on three, hence it would not required over 40 looms for 2000 spindles on this style of goods.

Note P.

The cost of the factories represented in the table which refers to this note, is based upon the modern style of building, the principal features of which are as follows: The thicknesses of the several brick walls are—the first story 20 inches, the second story 16 inches, the third and fourth stories 12 inches: the heights of the several ceilings in the clear are—the first story 12 feet, the second story 11 feet, the third and fourth stories 10 feet. The large girders are placed from 7 to 8½ feet apart, the floors are laid with two 1¼ plank and one 3 inch plank; the windows are placed from 7 to 8½ feet apart and generally contain 24 lights 8 by 10; fire-proof roof, generally tin; the stair-case or entrance

detached from the factory, which is generally 16 by 18 feet; brick are supposed to be worth 4½ dollars per thousand delivered on the site; the cost of different kinds of lumber is predicated upon the usual prices in the city of New York; the cost of the foundation up to the water sill is not included in these estimates.

BELTING.

BELTING.

The following table shows the velocity of belts—the column marked "Revolutions Shaft," shows the number of revolutions which the line or driven shaft is supposed to make per minute, the column marked "Diameter Drum," shows the diameter of the drum on the line or driven shaft.

EXAMPLE.

The line shaft is required to make 120 turns per minute, and it is desired to have the belt run 1800 feet per minute; required, the diameter of the driven drum—find 120 in the column marked "Revolutions Shaft," opposite to this number in the table find 1800, or the nearest to it, which is 1884 feet, over this number in the column marked "Diameter Drum," will be found 5 feet, the diameter of the drum.—*Answer.*

EXAMPLE.

The line shaft makes 100 turns per minute, the diameter of the driven drum is 4 feet; required, the number of feet the belt moves per minute—find 100 in the column marked "Revolutions Shaft," opposite to the number in the table, and under 4 in the column marked "Diameter Drum," will be found 1256 feet.—*Answer.*

No. 1.

Revolutions Shaft.	DIAMETER DRUM.								
	2	2½	3	3½	4	4½	5	5½	6
100	628	785	942	1099	1256	1413	1570	1727	1884
110	690	863	1036	1208	1381	1554	1727	1899	2072
120	753	942	1130	1318	1507	1695	1884	2072	2260
130	816	1020	1224	1428	1632	1836	2041	2245	2449
140	879	1099	1318	1538	1758	1978	2198	2417	2637
150	942	1177	1413	1648	1884	2119	2355	2590	2826
160	1004	1256	1507	1758	2009	2260	2512	2763	3014
170	1067	1334	1601	1868	2135	2402	2669	2935	3202
180	1130	1413	1695	1978	2260	2543	2826	3108	3391
190	1193	1491	1789	2088	2386	2684	2983	3281	3579
200	1256	1570	1884	2198	2512	2826	3140	3454	3768

The following table shows the required width of belts to transmit different number of horse power. The apparent degree of accuracy in this table is not obtained for any practical use, but to show the theoretical power of belts; when the belts exceed 12 inches in width the fractions may be omitted. This table is predicated upon the velocity of the belts being from 25 to 30 feet per second, which is the ordinary velocity; if the power to be transmitted exceeds 20 horse, and circumstances will not allow the centre of the drums to be over 15 feet apart, the power should be transmitted by gearing. (See Note E.)

EXAMPLE.

Required, the width of a belt to transmit 20 horse power from a water wheel, the diameter of the smallest drum being 6 feet—find 20 in the column marked "Horse Power," opposite to this number in the table, and under 6 in the column marked "Diameter," will be found 12 inches, the width of the belt.—*Answer.*

EXAMPLE.

Required, the width of a belt to transmit 100 horse power from an engine, the diameter of the smallest drum being 5 feet—find 100 in the column marked "Horse Power," opposite to this number in the table, and under 5 in the column marked "Diameter," will be found 72 inches, which can be divided into four 18 inch belts or any desired width.—*Answer.*

No. 2.

Horse Power.	DIAMETER.								
	2	3	4	5	6	7	8	9	10
1	1.8	1.2	0.9	0.72	0.6	0·514	0.45	0.4	0.36
2	3.6	2.4	1.8	1.44	1.2	1·028	0.90	0.8	0.72
3	5.4	3.6	2.7	2.16	1.8	1·542	1.35	1.2	1.08
4	7.2	4.8	3.6	2.88	2.4	2·056	1.80	1.6	1.44
5	9.0	6.0	4.5	3.60	3.0	2·570	2.25	2.0	1.80
6	10.8	7.2	5.4	4 32	3.6	3·084	2 70	2.4	2.16
7	12.6	8.4	6.3	5.04	4.2	3 598	3.15	2,8	2.52
8	14.4	9.6	7.2	5.76	4.8	4·112	3.60	3.2	2.88
9	16.2	10.8	8.1	6.48	5.4	4·626	4.05	3.6	3.24
10	18.0	12.0	9 0	7.20	6.0	5·140	4.50	4.0	3.60
12	21.6	14.4	10.8	8.64	7.2	6·168	5.40	4.8	4.32
14	25.2	16.8	12.6	10.08	8.4	7·196	6.30	5.6	5.04
16	28.8	19.2	14.4	11.52	9.6	8·224	7.20	6.4	5.76
18	32.4	21.6	16.2	12.96	10.8	9·252	8.10	7.2	6.48
20	36.0	24.0	18.0	14.40	12.0	10·280	9.00	8.0	7.20
25	45.0	30.0	22.5	18.00	15.0	12·850	11.25	10.0	9.00
30	54 0	36.0	27.0	21.66	18.0	15·420	13 50	12.0	10.80
35	63.0	42.0	31.5	25.20	21.0	17·990	15.75	14.0	12.60
40	72.0	48.0	36.0	28.80	24.0	20·560	18.00	16.0	14.40
45	81.0	54.0	40.5	32.40	27.0	23·130	20.25	18.0	16.20
50	90.0	60.0	45.0	36.00	30.0	25·700	22.50	20.0	18.00
55	99.0	66.0	49.5	39.60	33 0	28·270	24.75	22 0	19.80
60	108.0	72.0	54.0	43.20	36.0	30·840	27.00	24.0	21.60
65	117.0	78.0	58.5	46.80	39.0	33·410	29.25	26.0	23.40
70	126.0	84.0	63.0	50.40	42.0	35·980	31.50	28.0	25.20
75	135.0	90.0	67.5	54.00	45.0	38·550	33.75	30.0	27.00
80	144.0	96.0	72.0	57.60	48.0	41·120	36.00	32.0	28.80
85	153.0	102.0	76.5	61.20	51.0	43·690	38.25	34.0	30.60
90	162.0	108.0	81.0	64.80	54.0	46·260	40.50	36.0	32.40
95	171.0	114.0	85.5	68.40	57.0	48·830	42,75	38.0	34.20
100	180.0	120.0	90.0	72.00	60.0	51.400	45.00	40.0	36.00

It is immaterial whether the smallest drum is the driving or the driven drum; if the diameter of the smallest drum remains constant the width of the belt will remain constant, if the diameter of the other drum should be increased indefinitely.

The following table shows the required width of large belts to drive different number and kind of spindles with looms—the columns marked "Mules," "Mules and Frames," and "Frames," show the number and kind of spindles to be driven, the column marked "No. Yarn," shows the number of yarn which the spindles are supposed to spin, the column marked "Diameter," shows the diameter of the smallest drum.

No. 3.

Frame Spindles	No. Yarn.	DIAMETER.					
		3	4	5	6	7	8
1000	30 to 40	13	10	8	6½	5½	4¾
2000	" "	26	20	16	13	11	9
3000	" "	39	30	24	19	16	14
4000	" "	52	40	32	26	22	18
5000	" "	65	50	40	32	27	23
6000	" "	78	60	48	39	33	28

No. 4.

Mule Spindles	No. Yarn.	DIAMETER.					
		3	4	5	6	7	8
1000	10 to 20	13	10	8	7	6	5
2000	" "	27	20	16	13	11	10
3000	" "	40	30	24	20	17	15
4000	" "	54	40	32	27	23	20
5000	" "	67	50	40	34	28	25
6000	" "	81	61	49	40	34	30

No. 5.

Mule Spindles	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	20 to 30	12	9½	7½	6	5	4¾
2000	" "	25	19	15	12	10	9½
3000	" "	38	28	23	19	16	14
4000	" "	50	38	30	25	21	19
5000	" "	63	47	38	31	26	23
6000	" "	76	57	45	38	32	28

No. 6.

Mule Spindles	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	30 to 40	11½	9	7	5½	4¾	4¼
2000	" "	23½	17	14	11	9½	8½
3000	" "	35	26	21	17	14	13
4000	" "	47	35	28	23	19	17
5000	" "	58	44	35	29	24	21
6000	" "	70	52	42	35	29	26

No. 7.

Spindles Mule and Frame.	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	10 to 20	15	12	11	8	6½	6
2000	" "	30	24	21	15	13	11½
3000	" "	45	36	32	23	20	17
4000	" "	60	48	43	30	26	23
5000	" "	75	60	54	38	33	29
6000	" "	90	72	64	45	40	35

EXAMPLE.

Required, the width of a belt to drive 5000 frame spindles with looms, the number of the yarn being 35, and the diameter of the smallest drum being 6 feet—find 5000 in the column marked "Frame Spindles," opposite to this number in the table, and under 6 in the column marked "Diameter," will be found 32 inches, or two belts 16 inches wide.—*Answer.*

No. 8.

Spindles Mule and Frame.	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	20 to 30	13	10	8	6½	5½	5
2000	" "	26	20	16	13	11	10
3000	" "	39	29	24	20	17	15
4000	" "	52	39	31	26	22	20
5000	" "	65	49	39	33	28	25
6000	" "	78	58	47	39	33	30

No. 9.

Spindles Mule and Frame.	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	30 to 40	12	9	7	6	5	4½
2000	" "	24	18	14	12	10	9
3000	" "	36	27	21	18	15	13
4000	" "	48	36	29	24	20	18
5000	" "	60	45	36	30	25	22
6000	" "	72	54	43	36	31	27

No. 10.

Frame Spindles	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	10 to 20	16	12	10	8	7	6
2000	" "	32	24	19	16	14	12
3000	" "	48	36	29	24	21	18
4000	" "	65	48	39	32	27	24
5000	" "	81	61	48	40	34	30
6000	" "	97	73	58	49	41	36

EXAMPLE.

Required, the width of a belt to drive 2000 mule spindles with looms, the number of the yarn being 28, and the diameter of the smallest drum being 3 feet—find 2000 in the column marked "Mule Spindles," opposite to this number

in the table, and under 3 in the column marked "Diameter," will be found 25 inches, or two belts $12\frac{1}{2}$ inches wide. —*Answer.*

No. 11.

Frame Spindles	No. Yarn.	DIAMETER. 3	4	5	6	7	8
1000	20 to 30	14	11	$8\frac{1}{2}$	7	6	5
2000	" "	29	21	17	14	12	11
3000	" "	43	32	26	21	18	16
4000	" "	57	43	34	29	24	21
5000	" "	72	54	43	36	31	27
6000	" "	86	65	52	43	37	32

The following table shows the required width of counter belts to drive the counter shafts which drive the different machines represented in the following table.

No. 12.

PICKERS.

Beaters.	DIAMETER. 10	12	14	16	18	20	22	24	26	28	30
1	$6\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{4}$	$3\frac{3}{4}$	$3\frac{1}{4}$	3				
2	13	11	9	$8\frac{1}{2}$	$7\frac{1}{2}$	$6\frac{1}{2}$	6	$5\frac{1}{2}$	5	$4\frac{3}{4}$	$4\frac{1}{2}$
3	18	16	13	$12\frac{3}{4}$	11	$9\frac{1}{2}$	9	$7\frac{1}{4}$	$7\frac{1}{2}$	7	$6\frac{1}{2}$

No. 13.

30 INCH CARDS.

Cards	DIAMETER. 10	12	14	16	18	20	22	24	26	28	30
2	$5\frac{1}{4}$	$4\frac{1}{4}$	$3\frac{3}{4}$	$3\frac{1}{4}$	3	$2\frac{1}{2}$					
3	$7\frac{3}{4}$	$6\frac{1}{2}$	$5\frac{1}{2}$	$4\frac{3}{4}$	$4\frac{1}{2}$	4	$3\frac{1}{2}$	$3\frac{1}{4}$	3		
4	$10\frac{1}{2}$	$8\frac{1}{2}$	$7\frac{1}{2}$	$6\frac{1}{2}$	6	$5\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{1}{2}$
5	13	$10\frac{3}{4}$	9	8	$7\frac{1}{4}$	$6\frac{1}{2}$	6	$5\frac{1}{2}$	$5\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{1}{4}$
6	$15\frac{1}{2}$	13	11	$9\frac{1}{2}$	$8\frac{3}{4}$	8	7	$6\frac{1}{2}$	$6\frac{1}{2}$	$5\frac{1}{2}$	5
7	$18\frac{1}{2}$	$15\frac{1}{4}$	$12\frac{3}{4}$	$11\frac{1}{4}$	10	9	$8\frac{1}{2}$	$7\frac{3}{4}$	$7\frac{1}{4}$	$6\frac{1}{2}$	6
8	20	$17\frac{1}{2}$	$14\frac{1}{2}$	$12\frac{1}{2}$	$11\frac{1}{2}$	$10\frac{1}{2}$	$9\frac{1}{2}$	9	$8\frac{1}{2}$	$7\frac{1}{2}$	7
9	$23\frac{1}{2}$	$19\frac{1}{2}$	$16\frac{1}{2}$	$14\frac{1}{2}$	$13\frac{1}{4}$	12	$10\frac{1}{2}$	10	9	$8\frac{1}{4}$	$7\frac{1}{2}$
10	26	$21\frac{1}{2}$	18	16	$14\frac{1}{2}$	13	12	11	$10\frac{1}{4}$	$9\frac{1}{4}$	$8\frac{1}{4}$

No. 14.

DRAWING FRAMES, (3 HEADS EACH.)

Drawing.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
1	4	3¼	3	2½							
2	8	6½	6	5	4½	4	3½	3¼	3		
3	12	9¾	9	7½	6½	6	5½	4¾	4½	4¼	4

No. 15.

TWIST SPEEDERS.

Speeder.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
48	6¼	5½	4½	3¾	3½	3					
72	9¼	7¾	6½	5½	5¼	4½	4¼	4	3½	3¼	3
96	12½	10½	8¾	7½	6¾	6	5½	5¼	4¾	4½	4¼
120	15½	13	11¼	9½	8½	7½	7	6½	6	5½	5
144	18¾	15½	13½	11½	10¼	9	8½	7¾	7¼	6½	6¼
168	21¾	18¼	15¼	13¼	12	10½	9¾	9	8½	7¾	6¼
192	24¾	20¾	17½	15¼	13½	12	11¼	10¼	9½	8¾	8¼
216	29	23½	19¾	17	15¼	13½	12½	11¾	10¾	10	9

No. 16.

MULE SPINDLES.

Mule.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
600	12¼	10¼	8¾	7¼	6½	6	5½	5	4½	4¼	4
900	18½	15½	12¾	11¼	9¾	9¼	8¼	7½	6¾	6¼	6
1200	24½	20½	17¼	14¾	13¼	12¼	10¾	10¼	9¼	8½	8¼
1500	30¾	25¾	21½	18½	16½	15	13½	12½	11½	10½	10¼

EXAMPLE.

Required, the width of a counter belt to drive a picker with two beaters, the diameter of the smallest pulley being 18 inches—find 2 in the column marked "Beaters," opposite to this number in the table, and under 18 in the column

marked "Diameter," will be found 7 inches, the width of the required belt.—*Answer.*

No. 17.

FRAMES, (LIVE AND DEAD) SPINDLES.

Frame.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
100	8	6½	5¾	5	4½	4	3½	3¼	3		
200	16¼	13¼	11½	10¼	8¾	8¼	7¼	6½	6¼	5½	5¼
300	24½	19¾	17¼	15½	13½	12½	10¾	9¾	9¼	8½	7¾
400	32¾	26½	22¾	20½	17½	16½	14½	13¼	12¼	11¼	10½
500	40¾	33½	28½	25¾	22¼	20¾	18¼	16½	15¼	14	13¼

No. 18.

DRESSERS, (3 FANS TO EACH DRESSER.)

Dressers.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
1	7¼	5¾	5¼	4½	3¾	3½	3¼	3			
2	14½	11½	10½	8½	7½	7	6¼	5¾	5¼	5	4½
3	21½	17¼	15½	12¾	11¾	10½	9¼	8¾	8¼	7½	6¾
4	28¼	23¼	20¼	17¼	13¼	14¼	12½	11½	10¼	10	9¼

No. 19.

LOOMS.

Looms.	DIAMETER.										
	10	12	14	16	18	20	22	24	26	28	30
2	5¼	4¼	3¾	3¼	3						
4	10¼	8½	7¼	6½	5¾	5½	5¼	4¾	4½	4¼	3¾
6	15⅛	13¼	11¼	9½	8½	7¾	7¼	6½	6	5½	5¼
8	20¾	17½	14¼	12¾	11½	10½	9½	8¾	8¼	7¼	7
10	26¼	21½	17¾	16¼	14¼	13¼	11¾	10¾	10¼	9¼	8¾
12	31¼	26¼	22¼	19¼	17¼	15½	14½	13¼	12¼	11¼	10½

EXAMPLE.

Required, the width of a counter belt to drive 6 cards, the diameter of the smallest pulley being 20 inches—find 6

in the column marked "Cards," opposite to this number in the table, and under 20 in the column marked "Diameter," will be found 8 inches.—*Answer.*

EXAMPLE.

Required, the width of a counter belt to drive 1500 mule spindles, the diameter of the smallest pulley being 20 inches —find 1500 in the column marked "Mules," opposite to this number in the table, and under 20 in the column marked "Diameter," will be found 15 inches, the required width (or two belts 7 and 8 inches wide).—*Answer.*

The following table shows the width of the counter belt that drives the counter shaft, from which any number of large size board-planing machines from one to four may be driven—the column marked "Pulleys," shows the diameter of the smallest of the two pulleys on which the counter belt runs, the column marked "No. Machines," shows the number of machines to be driven.

EXAMPLE.

Required, the width of a belt to drive two board-planing machines, the diameter of the smallest pulley being 20 inches —find 20 in the column marked "Pulleys," opposite to this number in the table, and under 2 in the column marked "No. Machines," will be found 9 inches, the required width of a counter belt that drives a counter shaft, which drives two large size board-planing machines.—*Answer.*

EXAMPLE.

Required, the width of a counter belt to drive a counter shaft, which is to drive one board-planing machine, the smallest pulley being 12 inches in diameter—find 12 in the column marked "Pulleys," opposite to this number in the table, and under 1 in the column marked "No. Machines," will be found 7½ inches, the width of the belt.—*Answer.*

No. 20.

Pulleys.	No. MACHINES.			
	1	2	3	4
12	7½	15	22½	30
14	6½	13	19½	26
16	5½	11¼	16¾	22½
18	5	10	15	20
20	4½	9	13½	18
22	4	8¼	12¼	16½
24	3¾	7½	11¼	15
26	"	7	10½	13¾
28	"	6½	9½	12¾
30	"	6	9	12
32	"	5½	8½	11¼
34	"	5¼	8	10½
36	"	5	7½	10

Note E.

The following statement shows the surplus power of the belts in the table which refers to this note. The width of the belt was 18 inches, which run 1500 feet per minute, the angle of the belt was about 45 degrees; the distance between the centres of the drums was 25 feet; the diameter of the driving drum was 8 feet; the diameter of the driven drum was 4 feet; when the belt transmitted 20 horse power it worked quite freely, when the power was increased to 25 horse it was necessary to make the belt quite tight, when the power was increased to 28 horse power it was necessary to apply a tightening pulley, which caused the journals on the driven shaft to heat: this statement shows that the velocity of the belts in the table which refers to this note must not be less than 1500 feet per minute. From a great number of observations it appears that a belt will last longer when it does not run over 2000 feet per minute.

CORN AND FLOUR MILLS.

CORN AND FLOUR MILLS.

The following table shows the required area of all the openings in the inward or centre discharging turbine water wheel under different heads, to drive different number of $4\frac{1}{2}$ feet stones grinding corn—the column marked "Head," shows the effective head, the column marked "No. Run," shows the number of run of $4\frac{1}{2}$ feet stones.

EXAMPLE.

Required, the area of all the openings in an inward discharging turbine wheel, the head being 12 feet, to drive 2 run of $4\frac{1}{2}$ feet stones grinding corn—find 12 in the column marked "Head," opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 380 inches area.—*Answer.*

EXAMPLE.

Required, the area of all the openings in an inward discharging turbine wheel, the head being 20 feet, to drive 4 run of $4\frac{1}{2}$ feet stones grinding corn—find 20 in the column marked "Head," opposite to this number in table, and under 4 in the column marked "No. Run," will be found 352 inches area.—*Answer.*

No. 1.

Head	No. RUN (4½ FEET STONES.)			
	1	2	3	4
4	1000	2000	3000	4000
5	714	1428	2142	2856
6	543	1086	1629	2172
7	431	862	1293	1724
8	352	704	1056	1408
9	294	588	882	1176
10	252	504	756	1008
11	217	434	651	868
12	190	380	570	760
13	169	338	507	676
14	151	302	453	604
15	136	272	408	544
16	123	246	369	492
17	113	226	339	452
18	104	208	312	416
19	96	192	288	384
20	88	176	264	352
21	82	164	246	328
22	77	154	231	308
23	72	144	216	288
24	67	134	201	268
25	63	126	189	252
26	59	118	177	236
27	56	112	168	224
28	53	106	159	212
29	50	100	150	200
30	48	96	144	192

The following table shows the required area of all the openings in the inward or centre discharging turbine water wheel under different heads, to drive different number of 4½ feet stones grinding wheat, with all the attendant machinery —the column marked "Head," shows the effective head, the column marked "No. Run," shows the number of run of 4½ feet stones.

EXAMPLE.

The fall being 5 feet, required, the area of all the openings to drive one run of 4½ feet stones—find 5 in the column

marked "Head," opposite to this number in the table, and under 1 in the column marked "No. Run," will be found 600 inches, the area of all the openings.—*Answer.*

EXAMPLE.

The head heing 14 feet, required, the area of all the openings to drive 2 run of 4½ feet stones grinding wheat, with all the attendant machinery—find 14 in the column marked "Head," opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 242 inches area.—*Answer.*

No. 2.

	No. RUN (4½ FEET STONES.)			
Head	1	2	3	4
4	800	1600	2400	3200
5	600	1200	1800	2400
6	432	864	1296	1728
7	344	688	1032	1376
8	281	562	843	1124
9	235	470	705	940
10	202	404	606	808
11	173	346	519	692
12	152	304	456	608
13	135	270	405	540
14	121	242	363	484
15	109	218	327	436
16	99	198	297	396
17	90	180	270	360
18	83	166	249	332
19	77	154	231	308
20	71	142	213	284
21	66	132	198	264
22	61	122	183	244
23	57	114	171	228
24	54	108	162	216
25	50	100	150	200
26	47	94	141	188
27	45	90	135	180
28	43	86	129	172
29	40	80	120	160
30	38	76	114	152

The following table shows the required area of all the openings in the outward discharging turbine water wheel under different heads, to drive different number of $4\frac{1}{2}$ feet stones grinding corn. This table is predicated from several wheels, which are driving different number of $4\frac{1}{2}$ feet stones, the surplus power in the several cases noted. The column marked "Head," shows the effective head when the wheel is in operation, the column marked "No. Run," shows the number of $4\frac{1}{2}$ feet stones. (See Note B.)

No. 3.

	No. RUN ($4\frac{1}{2}$ FEET STONES.)			
Head	1	2	3	4
4	558	1116	1674	2232
5	363	726	1089	1452
6	311	622	933	1244
7	245	490	735	980
8	190	380	570	760
9	163	326	489	652
10	137	274	411	548
11	122	244	366	488
12	107	214	321	428
13	95	190	285	380
14	83	166	249	332
15	75	150	225	300
16	68	136	204	272
17	62	124	186	248
18	57	114	171	228
19	52	104	156	208
20	48	96	144	192
21	45	90	135	180
22	43	86	129	172
23	39	78	117	156
24	37	74	111	148
25	35	70	105	140
26	32	64	96	128
27	31	62	93	124
28	29	58	87	116
29	28	56	84	112
30	26	52	78	104

EXAMPLE.

The effective head being 16 feet, required, the area of all the openings in an outward discharging turbine wheel, to drive 2 run of $4\frac{1}{2}$ feet stones grinding corn—find 16 in the column marked "Head," opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 136 inches area.—*Answer.*

EXAMPLE.

The effective head being 5 feet, required, the area of all the openings to drive 2 run of $4\frac{1}{2}$ feet stones grinding corn—find 5 in the column marked "Head," opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 726 inches area.—*Answer.*

The following table shows the required area of all the openings in the outward discharging turbine water wheel, under different heads, to drive different number of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery. This table is predicated upon the actual results of several wheels, which are driving different number of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery, the surplus power in the several cases noted. The column marked "Head," shows the effective head, the column marked "No. Run," shows the number of $4\frac{1}{2}$ feet stones.

EXAMPLE.

The effective head being 12 feet, required, the area of all the openings in the outward discharging turbine water wheel, to drive 3 run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery—find 12 in the column marked "Head," opposite to this number in the table, and under 3 in the column marked "No. Run," will be found 267 inches area.—*Answer.*

EXAMPLE.

The effective fall being 20 feet, required, the area of all the openings to drive 2 run of 4½ feet stones grinding wheat, with all the attendant machinery—find 20 in the column marked "Fall," opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 82 inches, area of all the openings.—*Answer.*

No. 4.

	No. RUN (4½ FEET STONES.)			
Head	1	2	3	4
4	465	930	1395	1860
5	306	612	918	1224
6	259	518	777	1036
7	204	408	612	816
8	160	340	480	640
9	136	272	408	544
10	114	228	342	456
11	102	204	306	408
12	89	178	267	356
13	80	160	240	320
14	70	140	210	280
15	62	124	186	248
16	57	114	171	228
17	51	102	153	204
18	47	94	141	188
19	44	88	132	176
20	41	82	123	164
21	37	74	111	148
22	35	70	105	140
23	32	64	96	128
24	30	60	90	120
25	29	58	87	116
26	27	54	81	108
27	26	52	78	104
28	24	48	72	96
29	23	46	69	92
30	22	44	66	88

The following table shows the required length of overshot or breast wheels on different falls from 10 to 30 feet, to drive different number of 4½ feet stones, (grinding wheat,)

with all the attendant machinery. The column marked "Fall," shows the number of feet fall on the breast wheel, or the diameter of the overshot wheel; the column marked "No. Run," shows the number of run of stones to be driven.

EXAMPLE.

The fall (effective) on a breast wheel being 20 feet, what must be the length of the wheel to drive 4 run of $4\frac{1}{2}$ feet stones—find 20 in the column marked "Fall," opposite to this number in the table, and under 4 in the column marked "No. Run," will be found 14 feet, the length of the wheel. —*Answer.*

EXAMPLE.

An overshot wheel is 15 feet in diameter and 18 feet long, required, the number of run the wheel can drive—find

No. 5.

	No. RUN.			
Fall.	1	2	3	4
10	7	14	21	28
11	$6\frac{1}{2}$	$12\frac{1}{2}$	19	$25\frac{1}{4}$
12	$5\frac{3}{4}$	$11\frac{1}{2}$	$17\frac{1}{4}$	$23\frac{1}{4}$
13	$5\frac{1}{2}$	11	$16\frac{1}{2}$	22
14	5	10	15	20
15	$4\frac{1}{2}$	9	$13\frac{1}{2}$	18
16	$4\frac{1}{4}$	$8\frac{1}{2}$	13	$17\frac{1}{4}$
17	4	$8\frac{1}{4}$	$12\frac{1}{4}$	$16\frac{1}{2}$
18	4	$7\frac{3}{4}$	$11\frac{3}{4}$	$15\frac{1}{2}$
19	$3\frac{3}{4}$	$7\frac{1}{2}$	$11\frac{1}{4}$	15
20	$3\frac{1}{2}$	7	$10\frac{1}{2}$	14
21	$3\frac{1}{4}$	$6\frac{1}{2}$	10	$13\frac{1}{4}$
22	$3\frac{1}{4}$	$6\frac{1}{2}$	$9\frac{1}{2}$	$12\frac{3}{4}$
23	3	6	9	12
24	3	$5\frac{3}{4}$	$8\frac{3}{4}$	$11\frac{1}{2}$
25	$2\frac{3}{4}$	$5\frac{1}{2}$	$8\frac{1}{2}$	11
26	$2\frac{3}{4}$	$5\frac{1}{4}$	$8\frac{1}{4}$	$10\frac{1}{2}$
27	$2\frac{1}{2}$	5	$7\frac{3}{4}$	$10\frac{1}{4}$
28	$2\frac{1}{2}$	$4\frac{3}{4}$	$7\frac{1}{2}$	10
29	$2\frac{1}{2}$	$4\frac{1}{2}$	$7\frac{1}{4}$	$9\frac{3}{4}$
30	$2\frac{1}{4}$	$4\frac{1}{4}$	7	$9\frac{1}{2}$

15 in the column marked "Fall," opposite to this number in the table find 18, over this number in the column marked "No. Run," will be found 4 run of $4\frac{1}{2}$ feet stones.—*Answer.*

The following table shows the required length of overshot or breast wheel, to drive different number of $4\frac{1}{2}$ feet stones grinding corn—the column marked "Fall," shows the fall of the breast wheel, or the diameter of the overshot.

EXAMPLE.

Required, the length of an overshot wheel, the diameter being 16 feet, to drive 3 run of $4\frac{1}{2}$ feet stones grinding corn —find 16 in the column marked "Fall," opposite to this number in the table, and under 3 in the column marked

No. 6.

Fall.	No. RUN.			
	1	2	3	4
10	8	16	24	32
11	$7\frac{1}{4}$	$14\frac{1}{2}$	$21\frac{3}{4}$	29
12	$6\frac{1}{2}$	13	$19\frac{1}{2}$	26
13	6	$12\frac{1}{4}$	$18\frac{1}{4}$	$24\frac{1}{2}$
14	$5\frac{3}{4}$	$11\frac{1}{2}$	$17\frac{1}{4}$	23
15	$5\frac{1}{4}$	$10\frac{1}{2}$	$15\frac{3}{4}$	21
16	5	10	15	20
17	$4\frac{3}{4}$	$9\frac{1}{2}$	$14\frac{1}{4}$	19
18	$4\frac{1}{2}$	9	$13\frac{1}{2}$	18
19	$4\frac{1}{4}$	$8\frac{1}{2}$	$12\frac{3}{4}$	17
20	4	8	12	16
21	$3\frac{3}{4}$	$7\frac{1}{2}$	$11\frac{1}{4}$	15
22	$3\frac{1}{2}$	7	$10\frac{1}{2}$	14
23	$3\frac{1}{2}$	$6\frac{3}{4}$	$10\frac{1}{4}$	$13\frac{1}{2}$
24	$3\frac{1}{4}$	$6\frac{1}{2}$	10	$13\frac{1}{4}$
25	$3\frac{1}{4}$	$6\frac{1}{2}$	$9\frac{1}{2}$	$12\frac{3}{4}$
26	3	6	$9\frac{1}{4}$	$12\frac{1}{4}$
27	3	6	9	12
28	$2\frac{3}{4}$	$5\frac{3}{4}$	$8\frac{1}{2}$	$11\frac{1}{2}$
29	$2\frac{3}{4}$	$5\frac{1}{2}$	$8\frac{1}{4}$	11
30	$2\frac{1}{2}$	$5\frac{1}{4}$	8	$10\frac{1}{2}$

"No. Run," will be found 15 feet, the length of the wheel required.—*Answer.*

EXAMPLE.

A breast wheel is 12 feet long, and the fall being 13 feet, required, the number of $4\frac{1}{2}$ feet stones grinding corn that this wheel is capable of driving—find 13 in the column marked "Fall," opposite to this number in the table, find 12, or the nearest number to it, which is $12\frac{1}{4}$, over this number in the column marked "No. Run," will be found 2 run.—*Answer.*

CUT-NAIL MACHINES.

CUT-NAIL MACHINES.

The following table shows the required length of over-shot and breast wheel on different falls from 10 to 30 feet, to drive different number of cut-nail machines, with the attend-

No. 1.

Fall.	No. MACHINES.											
	4	6	8	10	12	14	16	18	20	22	24	26
10	4	6	8	10	12	14	16	18	20	22	24	26
11	3½	5½	7¼	9	10¾	12½	14½	16¼	18	19¾	21½	23½
12	3¼	5	6½	8	9¾	11¼	13	14½	16	17¾	19¼	21
13	3	4½	6	7¾	9¼	10¾	12¼	13¾	15½	17	18½	20
14	2¾	4¼	5½	7	8½	9¾	11¼	12½	14	15½	16¾	18¼
15		4	5¼	6½	7¾	9	10½	11¾	13	14¼	15½	17
16		3¾	5	6	7¼	8½	9¾	11	12	13¼	14½	15¾
17		3½	4½	5½	6¾	7¾	9	10	11½	12¼	13¼	14½
18		3¼	4½	5½	6½	7¾	8¾	10	11	12	13	14¼
19		3	4¼	5¼	6¼	7¼	8¼	9½	10½	11½	12½	13¼
20			4	5	6	7	8	9	10	11	12	13
21			3¾	4½	5½	6½	7½	8½	9½	10½	11¼	12½
22			3¼	4¼	5¼	5¾	6½	7¼	8	9	9¾	10½
23			3¼	4	5	5¾	6½	7	7¾	8¾	9½	10¼
24			3	4	4¾	5½	6¼	7	7¾	8¾	9½	10
25				4	4½	5¼	6	6¾	7½	8½	9	9¾
26				3¾	4¼	5	5¾	6¼	7	7¾	8½	9¼
27				3½	4¼	5	5½	6¼	7	7¾	8¼	9
28				3¼	4	4¾	5½	6	6¾	7½	8¼	8¾
29				3¼	3¾	4½	5¼	5¾	6½	7¼	7¾	8½
30				3¼	3¾	4½	5¼	5¾	6½	7¼	7¾	8½

ant machinery—the column marked "Fall," shows the fall of the breast wheel, or the diameter of an overshot wheel, the column marked "No. Machines," shows the number of machines to be driven.

EXAMPLE.

The fall on a breast wheel being 12 feet, required, the length to drive 20 cut-nail machines—find 12 in the column marked "Fall," opposite to this number in the table, and under 20 in the column marked "No. Machines," will be found 16 feet, the length of the wheel.—*Answer.*

EXAMPLE.

An overshot wheel is 18 feet in diameter and 12 feet long, required, the number of cut-nail machines that this wheel is capable of driving—find 18 in the column marked "Fall," opposite to this number in the table, find 12, over this number in the column marked "No. Machines," will be found 22 machines.—*Answer.*

FURNACES.

FURNACES.

The following table shows the required length of overshot and breast wheels on different falls, from 11 to 30 feet, to drive the blast, &c., to furnaces which turn off different number of tons of No. 1 Iron per day, from 1 to 14 tons—the column marked "Fall," shows the number of feet fall on the breast wheel, or the diameter of the overshot wheel.

EXAMPLE.

Required, the length of an overshot wheel to turn off 6 tons per day of No. 1, Iron, the diameter of the wheel being 20 feet—find 20 in the column marked "Fall," opposite to this number in the table, and under 6 in the column marked "No. Tons," will be found 10 feet, the length of the wheel. —*Answer.*

EXAMPLE.

The fall on a breast wheel being 12 feet, and the length of the wheel being 12 feet, required, the number of tons of No. 1 Iron that this wheel will supply power for, making per day—find 12 in the column marked "Fall," opposite to this number in the table find 12, over this number in the column marked "No. Tons," will be found 4 tons, which this wheel will produce per day.—*Answer.*

No. 1.

Fall.	No. Tons. 1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	3¼	6½	9½	12¾	16	19¼	22½	25½	28¾	32	35¼	38½	41½	44¾
12	3	6	9	12	15	18	21	24	27	30	33	36	39	42
13	2¾	5½	8	11	13½	16	19	21½	24	27	29¾	32½	35	38
14	2½	5	7½	10	12½	15	17½	20	22½	25	27½	30	32½	35
15	2½	4¾	7	9½	12	14½	16¾	19	21½	24	26½	28¾	31¼	33½
16	2¼	4½	6½	8¾	11	13	15½	17¾	20	22	24¼	26½	28¾	31
17	2	4	6	8¼	10¼	12½	14½	16½	18½	20½	22½	24¾	26¾	28¾
18	2	4	6	8	10	12	14	16	18	20	22	24	26	28
19	1¾	3½	5½	7¼	9	10¾	12½	14¼	16½	18	19¾	21½	23½	25¼
20			5	6¾	8½	10	12	13½	15	17	18¾	20½	22	24
21			5	6½	8¼	9¾	11¾	13¼	14¾	16½	18½	20	21½	23½
22			4¾	6¼	8	9½	11¼	12¾	14¼	16	17½	19	21	22½
23			4½	6	7½	9	10½	12	13½	15	16½	18	19½	21
24			4¼	5½	7	8½	9¾	11¼	12½	14	15½	16¾	18¼	19½
25			4¼	5½	6¾	8¼	9½	11	12	13½	14¾	16	18	19
26			4	5¼	6½	7¾	9	10½	11¾	13	14¼	15½	17	18¼
27			4	5	6¼	7¼	8½	10	11¼	12½	13¾	15	16¼	17½
28				4¾	6	7	8¼	9½	10¾	12	13¼	14½	15½	16¾
29				4½	5¾	6¾	8	9¼	10¼	11¾	13	14	15¼	16¼
30				4½	5¾	6¾	8	9	10¼	11½	12½	13¾	15	16

MISCELLANEOUS MACHINERY.

MISCELLANEOUS MACHINERY.

The following tables show the actual and calculated power required to drive the different machines represented. The column marked "4½ Feet Stones, Corn," shows the number of 4½ feet stones grinding corn to be driven, the column marked "Actual Power," shows the actual power required, the column marked "Calculated Power," shows the usual power of the engine or water wheel.

EXAMPLE.

Required, the calculated power to drive 3 large size circular saws—find 3 in the column marked "Circular Saws," (in No. 1 Table,) opposite to this number in the column marked "Calculated Power," will be found 15 horse power. —*Answer.*

EXAMPLE.

Required, the calculated power to drive 4 large size board planing machines—find 4 in the column marked "Planing Machines," (in No. 3 Table,) opposite to this number in the column marked "Calculated Power," will be found 24 horse power.—*Answer.*

No. 1.

Circular Saws.	Calclatd Power.	Actual Power.
1	5	4
2	10	8
3	15	12
4	20	16
5	25	20
6	30	24

No. 2.

Upright Saws.	Calclatd Power.	Actual Power.
1	7	5
2	14	10
3	21	15
4	28	20
5	35	25
6	42	30

EXAMPLE.

Required, the calculated power to drive 3 run of $4\frac{1}{2}$ feet stones grinding corn—find 3 in the column marked "$4\frac{1}{2}$ feet Stones, Corn," opposite to this number in the column marked "Calculated Power," will be found 48 horse power.—*Answer.*

EXAMPLE.

Required, the calculated power to drive 2 run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery—find 2 in the column marked "$4\frac{1}{2}$ Feet Stones, Wheat," opposite to this number in the column marked "Calculated Power," will be found 28 horse power.—*Answer.*

EXAMPLE.

Required, the calculated power to drive the blast, &c., to a furnace which makes 5 tons of No. 1 Iron per day—

find 5 in the column marked "Tons of Iron," opposite to this number in the column marked "Calculated Power," will be found 35 horse power.—*Answer.*

EXAMPLE.

Required, the calculated power to drive 12 cut-nail machines of different size, with attendant machinery (grindstones, plate-cutter, blast, &c.)—find 12 in the column marked "Nail Machines," opposite to this number in the column marked "Calculated Power," will be found 24 horse power. —*Answer.*

No. 3.

Planing Machins	Calclatd Power.	Actnal Power.
1	6	5
2	12	10
3	18	15
4	24	30
5	30	25
6	36	30

No. 4.

Stones 4½ feet. Corn.	Actnal Power.	Calclatd Power.
1	14	16
2	28	32
3	32	48
4	56	64
5	70	80

No. 5.

Stones 4½ feet Wheat.	Actual Power.	Calclatd Power.
1	12	14
2	24	28
3	36	42
4	48	56
5	60	70

No. 6.

Tons of No. 1 Iron.	Actual Power.	Calclatd Power.
1	6	7
2	12	14
3	18	21
4	24	28
5	30	35
6	36	42
7	42	49
8	48	56
9	54	63
10	60	70

No. 7.

Nail Machins	Actual Power	Calclatd Power.
6	9	12
7	10	14
8	12	16
9	13	18
10	15	20
11	16	22
12	18	24
13	19	26

PADDLE WHEELS.

PADDLE WHEELS.

The following table shows the number of miles per hour that a steamboat moves, when the diameter of the wheel and the number of revolutions which it makes per minute are known—the column marked "Revolutions," shows the number of revolutions that the paddle wheel makes per minute, the column marked "Diameter," shows the diameter of the paddle wheel in feet.

EXAMPLE.

Required, the number of miles per hour that a boat is moving, the diameter of the wheels being 30 feet, and the wheels making 20 revolutions per minute—find 20 in the column marked "Revolutions," opposite to this number in the table, and under 30 in the column marked "Diameter," will be found 21.43 miles per hour. This would be the velocity of the boat if the water did not yield.—*Answer.*

EXAMPLE.

The diameter of the paddle wheel being 26 feet, and the number of revolutions per minute being 14, required, the number of miles the boat is moving per hour—find 14 in the column marked "Revolutions," opposite to this number in

the table, and under 26 in the column marked "Diameter," will be found 12.99 miles per hour.—*Answer.*

No. 1.

Revolutions.	DIAMETER.										
	24	25	26	27	28	29	30	31	32	33	34
14	11.99	12.49	12.99	13.49	13.99	14.49	14.99	15.49	15.99	16.49	16 99
15	12.85	13.38	13.92	14.46	14 99	15.53	16.06	16.60	17.14	17.67	18.21
16	13.70	14.28	14.85	15.42	15.99	16.57	17.14	17.71	18.28	18.85	19.42
17	14.56	15.17	15.78	16.39	16.99	17.60	18.21	18.82	19.43	20.03	20.64
18	15.42	16.06	16.71	17 35	17.99	18.64	19.28	19.93	20.57	21.21	21 86
19	16.28	16.96	17.64	18.32	19.00	19.68	20.36	21.04	21.72	22.40	23.08
20	17.13	17.85	18.56	19.28	20.00	20.71	21.43	22.14	22.86	23.58	24.29
21	17.99	18.74	19.49	20.25	21.00	21.75	22.50	23.25	24.01	24.76	25.51
22	18.85	19.63	20.42	21.21	22.00	22.79	23.57	24.36	25.15	25.94	26.73
23	19.70	20.53	21.35	22.18	23.00	23.82	24.65	25.47	26.30	27.15	27.94
24	20.56	21.42	22.28	23.14	24.00	24.86	25.72	26.58	27.44	28.30	29.16
25	21.42	22.31	23.21	24.11	25.00	25.90	26.79	27.69	28.59	29.48	30.38
26	22.27	23.21	24.13	25.07	26.00	26.94	27 87	28.80	29.73	30.66	31.59

The following table shows the number of revolutions of the paddle wheel due to the actual velocity of the boat; that is, the number of revolutions due to the per cent slip of the wheel is deducted from the whole number of revolutions of the wheel per minute—the column marked "Revolutions," shows the number of revolutions which the paddle wheel makes per minute, the column marked "Per Cent," shows the per cent slip of the paddle wheel.

EXAMPLE.

A paddle wheel makes 20 revolutions per minute, and the slip (or the yielding of the water) of the wheel is 20 per cent; required, the number of revolutions due to the velocity of the boat—find 20 in the column marked "Revolutions," below this number in the table, and opposite to 20 in the column marked "Per Cent," will be found 16 revolutions; that is, if the water did not yield, the wheel would

not make but 16 revolutions per minute to impel the boat with the same velocity which 20 revolutions per minute would when there is 20 per cent slip.—*Answer.*

Example.

A paddle wheel makes 16 revolutions per minute, and the slip is 16 per cent; required, the number of revolutions due to the velocity of the boat—find 16 in the column marked "Revolutions," below this number in the table, and opposite to 16 in the column marked "Per Cent," will be found 13 revolutions.—*Answer.*

No. 2.

Per Cent.	REVOLUTIONS.																								
14	14	15	16	17	18	19	20	21	22	23	24	25	26												
16	12	13	14	15	15	16	17	18	19	20	21	21	22												
18	11	12	13	14	15	15	16	17	18	19	20	21	22												
20	11	12	13	14	14	15	15	16	17	18	19	20	21												
22	11	12	12	13	14	14	15	16	16	17	18	19	20												
24	11	11	12	13	13	14	15	15	16	17	18	19	20												
26	10	11	12	12	13	14	14	15	16	16	17	18	19												
28	10	10	11	12	13	13	14	15	15	16	17	18	19												
30	10	10	11	12	12	13	14	14	15	16	16	17	18												
32	9	10	10	11	12	13	13	14	15	15	16	17	18												
34	9	9	10	11	11	12	13	14	14	15	16	16	17												
36	9	9	10	10	11	12	12	13	14	14	15	16	17												
38	9	9	9	10	11	11	12	13	13	14	15	15	16												
40	8	9	9	10	10	11	12	12	13	14	14	15	16												
42	8	8	9	9	10	11	11	12	13	13	14	15	15												
44	8	8	8	9	10	10	11	12	12	13	14	14	15												
46	8	8	8	9	9	10	11	11	12	13	13	14	15												
48	7	8	8	8	9	10	10	11	11	12	13	13	14												
50	7	7	8	8	9	9	10	10	11	12	12	13	13												

It would appear from the following statement that there is a fixed relation existing between the per cent loss of power of the steamboat paddle wheel (due to the yielding properties of the water), and the relative velocity of the circumference of the wheel and the velocity of the boat.

Let there be a large gear wheel secured on each end of the paddle wheel shaft, nearly equal in diameter to the paddle wheel; let these gear wheels work into racks which rest on surfaces at or below the surface of the water; let the racks be indefinite in length, and void of gravity, and allowed to move freely on the surface on which they rest; let the racks be held in their position by a chain connected to the end of each rack, and passing over carrying pulleys; on the other end of the chains let there be weights suspended, so that when the gear wheel makes 12 turns per minute the weights will be just in equilibrium; then the velocity of the boat will be equal to the velocity of the circumference of the gear wheel. Now let the gear wheel make 16 turns per minute, then the velocity of the boat will be greater than the velocity due to 12 turns per minute, but less than the velocity due to 16 turns per minute, and the velocity of the racks or weights will be equal to the relative velocity. It is a well established law, that the momentum of matter in motion is equal to its weight, multiplied by its velocity; if the weight remains constant the momentum will vary as the velocity, hence the momentum in this case varies as the velocity of the weights. It is a well known law, that the power required to put matter in motion is equal to the momentum of the matter when in motion, therefore the power required to put these weights in motion varies as the relative velocity; again, the momentum of these weights does not tend in any manner to impel the boat, therefore the power transmitted from the engine to these weights is lost to that end.

Now the water acts against the paddle wheels in the same manner as the racks act against the gear wheels. It is

a well known law, that action and reaction is equal in opposite directions; that is, the water reacts against the paddle wheel with the same force that the wheel acts against the water; if the water does not yield there is no momentum implied, because there is no motion implied, but if the water yields then there is momentum implied; and if the water yields with a velocity equal to the velocity of the boat, then will the power spent in putting the water in motion be equal to the power spent in putting the boat in motion, because action and reaction is equal in opposite directions.

PROBLEMS.

PROBLEMS.

No. 1.

The effective fall at Matteawan, New-York, being 29 feet, the length of the dam being 100 feet, and the depth of the water on the dam at low water mark being 3 inches; required, the number of cubic feet of water passing over the dam per second—find 3 in the column marked "Depth," (in Table No. 2, Water Power,) opposite to this number in the column marked "No. Feet," will be found .42, which multiplied by 100 gives 42 cubic feet of water passing over the dam per second.—*Answer.*

No. 2.

Required, the number of horse power that 42 cubic feet of water per second will produce if applied to an overshot wheel 29 feet in diameter—find 42 in the column marked "No. Feet," (in Table No. 3,) opposite to this number in the table, and under 29 in the column marked "Diameter," will be found 92.4 horse power.—*Answer.*

No. 3.

Required, the length of an overshot wheel 29 feet in diameter to transmit 92.4 horse power—find 29 in the column marked "Diameter," (in Table No. 9, Water Power,) op-

posite to this number in the table find 92.4, or the nearest number to it which is 90.4 ; over this number in the column marked "Length," will be found 16 feet, the length of the wheel.—*Answer.*

No. 4.

Required, the area of the canal to convey the water from the dam to the wheel—find 16, the length of the wheel, in the column marked "Length," (in Table No. 4, Water Power,) opposite to this number in the column marked "Area," will be found 27 feet ; if the water in the canal is 4 feet deep, the canal will be nearly 7 feet wide, because 4 multiplied by 7 is nearly equal to 27 feet.—*Answer.*

No. 5.

Required, the depth of the water in the wheel pit, the width of the race being equal to the length of the wheel, which is 16 feet—find 42 cubic feet of water in the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 16 in the column marked "Width," will be found 10 inches, the difference in the depth of the water when the wheel is at rest and in motion.—*Answer.*

No. 6.

Required, the width of the belt to transmit 92 horse power, the diameter of the smallest drum being 6 feet—find 92 or the nearest number to it in the column marked "Horse Power," (in Table No. 2, Belting,) opposite to 95 in the table, and under 6 in the column marked "Diameter," will be found 57 inches, or three belts 19 inches each.—*Answer.*

No. 7.

Required, the number of mule and frame spindles with looms on No. 36 yarn that 92 horse power is capable of dri-

ving—find 92 or the nearest number to it which is 94.5, in the column marked "Actual Power," (in Table No. 3, Manufacturing,) opposite to this number in the column marked "Mule and Frame Spindles," will be found 9000 spindles with looms.—*Answer.*

No. 8.

Required, the attendant machinery for 9000 mule and frame spindles, the number of the yarn being 36—find 9000 in the column marked "Mule and Frame Spindles," (in Table No. 12, Manufacturing,) opposite to this number in the different columns will be found, 1 willower, 3 two beater pickers, 54 thirty-inch cards, 9 railway heads, 4 drawing frames three heads each, 90 coarse speeder spindles, 342 fine speeder spindles, 252 spooler spindles, 5 warpers, 6 dressers, 225 looms.—*Answer.*

No. 9.

The factory being three stories high and 50 feet wide, required, the length to contain 9000 spindles with looms—find 9000 in the column marked "Spindles," (in Table No. 2, Manufacturing,) opposite to this number in the table, and under 50 in the column marked "Width," will be found 297 feet, the length of the building.—*Answer.*

No. 10.

Required, the number of operatives to operate 9000 spindles on No. 36 yarn—find 9000 in the column marked "Spindles," (in Table No. 16,) opposite to this number in the table, and under 35 in the column marked "No. Yarn," will be found 243 operatives.—*Answer.*

No. 11.

Required, the amount paid per week to operate 9000 spindles with looms on No. 36 yarn per week, (including all

expenses except the cost of the cotton,)—find 9000 in the column marked "Spindles," (in Table No. 17,) opposite to this number in the table, and under 35 in the column marked "No. Yarn," will be found 1188 dollars.—*Answer.*

No. 12.

Required, the contents of a boiler to heat a factory containing 9000 spindles with looms—find 9000 in the column marked "Spindles," (in Table No. 15, Manufacturing,) opposite to this number in the column marked "Contents," will be found 414 cubic feet; if the boiler is 4 feet in diameter the length will be nearly 33 feet, because the area of 4 feet cylinder is 12.5 feet, and 414 divided by 12.5 gives 33 nearly.—*Answer.*

No. 13.

Required, the number of tons of anthracite coal per year to heat a factory containing 9000 spindles—find 9000 in the column marked "Spindles," (in Table No. 14, Manufacturing,) opposite to this number in the column marked "Tons," will be found 144 tons.—*Answer.*

No. 14.

The effective fall at the City of Columbus, Georgia, is 14 feet, the length of the dam is 500 feet, and the depth of the water on the dam at the usual low water mark is 16 inches; required, the number of cubic feet of water passing over the dam per second—find 16 in the column marked "Depth," (in Table No. 2, Water Power,) opposite to this number in the column marked "No. Feet," will be found 5.24, which multiplied by 500 gives 2620 cubic feet of water passing over the dam per second.—*Answer.*

No. 15.

Required, the number of horse power that 2620 cubic feet of water per second will produce if applied to overshot

wheels—find 50 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 14 in the column marked "Diameter," will be found 53 horse power; then, if 50 cubic feet will give 53 horse power, 2620 cubic feet will by simple proportion give 2777 horse power.—*Answer.*

No. 16.

Required, the number of overshot or breast wheels to transmit 2777 horse power, the wheels being 14 feet long—find 14 in the column marked "Diameter," (in Table No. 9, Water Power,) opposite to this number in the table, and under 14 in the column marked "Length," will be found 38.2, the horse power of one wheel 14 feet long; then, if 2777 is divided by 38.2 the result will give the number of wheels, which is 72, each 14 feet long.—*Answer.*

No. 17.

Required, the number of frame spindles with looms on No. 14 yarn, that 2777 horse power is capable of driving—find 142.5 in the column marked "Actual Power," (in Table No. 3, Manufacturing,) opposite to this number in the column marked "Frame Spindles," will be found 10,000 spindles; then, if 142.5 horse power will drive 10,000 frame spindles with looms, 2777 horse power will by simple proportion drive 194,877 frame spindles with looms on No. 14 yarn.—*Answer.*

No. 18.

Required, the number of pounds of cotton that 194,877 spindles on No. 14 yarn will manufacture per week—find 14 in the column marked "No. Yarn," (in Table No. 34, Manufacturing,) opposite to this number in the table, and under 4000 in the column marked "No. Spindles," will be found 1336 pounds, which multiplied by 6 gives 8016 pounds per week; then, if 4000 frame spindles turn off 8016 pounds

per week, 194,877 frame spindles will by simple proportion produce 390,534 per week, or about 48,800 bales per year; there is from 12 to 15 per cent waste in the cotton, which would increase the amount of cotton.—*Answer.*

No. 19.

Required, the number of operatives to operate 194,877 frame spindles with looms on No. 14 yarn—find 10,000 in the column marked "Spindles," (in Table No. 16, Manufacturing,) opposite to this number in the table, and under 15 in the column marked "No. Yarn," will be found 330 operatives; then, if 1000 spindles require 330, 194,877 spindles will by simple proportion require 6431 operatives.—*Answer.*

No. 20.

Required, the amount paid per week to operate 194,877 frame spindles with looms on No. 14 yarn, (including all expenses except the cost of cotton,)—find 10,000 in the column marked "Spindles," (in Table No. 17, Manufacturing,) opposite to this number in the table, and under 15 in the column marked "No. Yarn," will be found 1600 dollars; then, if 10,000 spindles require 1600 per week, 195,877 spindles will by simple proportion require 31,180 dollars per week.—*Answer.*

No. 21.

The length of a dam being 20 feet, and the depth of the water on the dam being 5 inches, required, the number of cubic feet of water passing over the dam per second—find 5 in the column marked "Depth," opposite to this number in the column marked "No. Feet," (in Table No. 2, Water Power,) will be found 92, which multiplied by 20 gives 18.40, say 18 feet.—*Answer.*

No. 22.

The constant supply of water on a sill being 18 cubic feet of water per second, and the effective fall being 30 feet, required, the number of mule spindles with looms on No. 36 yarn, that this power is capable of driving—find 18 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 30 in the column marked "Diameter," will be found 40.96 horse power—find 40.96, or the nearest number to it which is 39, in the column marked "Actual Power," (in Table No. 3, Manufacturing,) opposite to this number in the column marked "Mule Spindles," will be found 4000 spindles with looms on No. 36 yarn.—*Answer.*

No. 23.

The fall on a site is 16 feet, deduct from this three feet, when the effective fall will be 13 feet; required, the length of an overshot wheel to drive 4000 mule and frame spindles on No. 30 yarn with looms—find 13 in the column marked "Fall," opposite to this number in the table, (in Table No. 7, Manufacturing,) and under 4000 in the column marked "No. Spindles," will be found 24 feet, or two 12 foot wheels. —*Answer.*

No. 24.

A breast wheel is required to work its actual power on a fall of 14 feet, the length of the wheel being 12 feet, and the race being 4 feet wide; required, the depth of the water in the wheel pit. The horse power of this wheel is 32.7, (found in Table No. 9, Water Power,) refer to Table No. 3, Water Power—find 14 in the column marked "Diameter," under this number in the table find 32.7, or the nearest number to it which is 32.86, opposite to this number in the column marked "No. Feet," will be found 31 cubic

feet discharged from the wheel per second—find 31 in the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 4 in the column marked "Width," will be found 21 inches, the depth of the water in the wheel pit when the water is in motion. —*Answer.*

No. 25.

The effective fall on a site being 13 feet, and the number of cubic feet of water passing in the stream per second (found from a dam on the stream,) being 35, required, the horse power—find 35 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 13 in the column marked "Diameter," will be found 34.44 horse power.—*Answer.*

No. 26.

The effective head being 13 feet, required, the area of all the openings in an inward or centre discharging turbine water wheel, to transmit 34.44 horse power—find 13 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 88 horse power; then, if 88 horse power require 100 inches area, 34.44 horse power will by simple proportion require 391 inches area.—*Answer.*

No. 27.

Required, the number of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery that this power is capable of driving—find 13 in the column marked "Head," (in Table No. 2, Flour and Corn Mills,) opposite to this number in the column marked "Area," will be found 135; then, if 135 inches area will drive one run of $4\frac{1}{2}$ feet stones, 391 inches area will by simple proportion drive nearly 3 run of

4_2 feet stones grinding wheat, with all the attendant machinery.—*Answer.*

No. 28.

Required, the depth of the water in the wheel pit, the width of the race being 6 feet, (35 feet per second is the number discharged from the wheel,)—find 35 in the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 6 in the column marked "Width," will be found 17 inches, the depth of the water in the wheel pit when the wheel is in motion.—*Answer.*

No. 29.

Required, the length of an overshot water wheel, the diameter being 12 feet, to drive 2 run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery—find 12 in the column marked "Fall," (in Table No. 5, Corn and Flour Mills,) opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 11_2 feet, the calculated length of the wheel.—*Answer.*

No. 30.

Required, the length of an overshot wheel, the diameter being 22 feet, to drive 3 run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery—find 22 in the column marked "Fall," (in Table No. 5, Corn and Flour Mills,) opposite to this number in the table, and under 3 in the column marked "No. Run," will be found $9\frac{1}{2}$ feet, the calculated length of the wheel.—*Answer.*

No. 31.

Required, the length of an overshot wheel, the diameter being 16 feet, to drive 2 run of $4\frac{1}{2}$ feet stones grinding corn —find 16 in the column marked "Fall," (in Table No. 6,

Corn and Flour Mills,) opposite to this number in the table, and under 2 in the column marked "No. Run," will be found 10 feet, the length of the wheel.—*Answer.*

No. 32.

The head being 16 feet, and the area of all the openings in an inward discharging turbine water wheel being 297 inches, required, the number of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery this wheel is capable of driving—find 16 in the column marked "Head," opposite to this number in the table find 297, over this number in the column marked "No. Run," will be found 3, the number of run this wheel is capable of driving.—*Answer.*

No. 33.

The whole fall on a site being $32\frac{1}{2}$ feet, required, the per cent loss of an overshot wheel due to this fall, and the per cent loss of an overshot wheel due to half of this fall; (in this problem it is necessary to suppose the statement in Note A to be correct;) the diameter of an overshot wheel due to $32\frac{1}{2}$ feet fall is 30 feet, the diameter due to half of this fall is $13\frac{3}{4}$ feet—find 30 in the column marked "Fall," (in Table No. 10, Water Power,) opposite to this number in the column marked "Per Cent," will be found 23 per cent—find 14 in the column marked "Fall," opposite to this number in the column marked "Per Cent," will be found 38 per cent: the per cent loss due to $13\frac{3}{4}$ feet is 39 per cent nearly; the difference of 39 and 23 is 16 per cent; allow 6 per cent for the difference in the inertia of the wheels when loaded, and also the difference in the power due to the water on the wheel when any part of the machinery is stopped, which is very small unless the power is lost when the wheel runs above its calculated velocity; then the lost power by dividing the fall into two falls will be 10 per cent.—*Answer.*

No. 34.

The effective fall being 5 feet, and the diameter of an outward discharging turbine water wheel being 72 inches, required, the number of revolutions of the wheel per minute —find 5 in the column marked "Head," opposite to this number in the table, and under 72 in the column marked "Diameter," will be found 41 revolutions.—*Answer.*

No. 35.

The whole fall of a stream or site is 18 feet; this site is subject to two feet back-water three months in the year; but when there are two feet back-water the head is raised one foot; the water on the dam being one foot deep then the whole fall is 17 feet; allow two feet for the head being drawn down &c., then the effective fall will be 15 feet; required, the area of all the openings in an inward discharging turbine water wheel, to drive one run of 4½ feet stones grinding wheat, with all the attendant machinery—find 15 in the column marked "Head," (in Table No. 2, Corn and Flour Mills,) opposite to this number in the table, and under 1 in the column marked "No. Run," will be found 109 inches area.—*Answer.*

No. 36.

The fall on a breast wheel being 18 feet; there are five gates to let the water on the wheel, the upper gate being under a head of 2 feet, and the lower gate under a head of 10 feet; required, the per cent loss of the wheel when supplied with water from the upper gate under a head of 2 feet, and the per cent loss when supplied from the lower gate under a head of 2 feet, (according to the statement in Note A)—find 18 in the column marked "Fall," (in Table No. 10, Water Power,) opposite to this number in the column marked "Per Cent," will be found 33 per cent loss; find

10 in the column marked "Fall," (which is the fall from the lower gate,) opposite to this number in the column marked "Per Cent," will be found 49 per cent loss of power.—*Answer.*

No. 37.

Required, the area of all the openings in an outward discharging turbine water wheel, to drive 1 run of $4\frac{1}{2}$ feet stones grinding corn, the effective head when the reservoir is full being 16 feet; the reservoir is frequently drawn down 6 feet, as the constant supply of water is not sufficient to drive the wheel, hence the wheel must be calculated for 10 feet fall—find 10 in the column marked "Head," opposite to this number in the table, (in Table No. 3, Corn and Flour Mills,) and under 1 in the column marked "No. Run," will be found 137 inches area.—*Answer.*

No. 38.

The diameter of the wheel in No. 37 Problem, being 48 inches, required, the number of revolutions per minute; take some number between 16 and 10—as the average head will be nearer 16 than 10, choose 14—find 14 in the column marked "Head," (in Table No. 13, Water Power,) opposite to this number in the table, and under 48 in the column marked "Diameter," will be found 102 revolutions.—*Answer.*

No. 39.

The effective fall being 16 feet, required, the area of all the openings in an inward discharging turbine water wheel, to drive two run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery—find 16 in the column marked "Head," (in Table No. 2, Corn and Flour Mills,) opposite to this number in the table, and under 2 in the column

marked "No. Run," will be found 198 inches area.—*Answer.*

No. 40.

Required, the horse power of the wheel in No. 39 Problem, the effective fall being 16 feet—find 16 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 12.1 horse power; then, if 100 inches area gives 12.1 horse power, 198 inches area will by simple proportion give 24 horse power nearly.—*Answer.*

No. 41.

Required, the number of cubic feet of water discharged from the wheel in No. 39 Problem per second, (supposing this wheel to produce the same effect as the overshot or breast wheel on the same fall,)—find 16 in the column marked "Diameter," (in Table No. 3, Water Power,) below this number in the table, find 24 horse power, or the nearest number to it, which is 24.24, opposite to this number in the column marked "No. Feet," will be found 20 cubic feet of water; in this case 2½ feet of the fall should be allowed for head and clearance, same as allowed to the overshot wheel, then the whole fall will be 18_2 feet.—*Answer.*

No. 42.

Required, the depth of the water in the wheel pit in No. 39 Problem, the width of the race being 6 feet—find 20 (cubic feet, the number discharged from the wheel per second) in the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 6 in the column marked "Width," will be found 12 inches, the depth of the water in the wheel pit when the wheel is running.—*Answer.*

No. 43.

Required, the depth of the water in the wheel pit in No. 39 Problem, the width of the race being 12 feet—find 20 in the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 12 in the column marked "Width," will be found 7 inches, the depth of the water.—*Answer.*

No. 44.

Required, the length of an overshot water wheel, the fall being 16 feet, to drive the blast, &c., to a furnace which turns off 6 tons of No. 1 Iron per day—find 16 in the column marked "Fall," (in Table No. 1, Furnace,) opposite to this number in the table, and under 6 in the column marked "No. Tons," will be found 13 feet, the length of the wheel.—*Answer.*

No. 45.

For each ton of No. 1 Iron per day it requires about 7 calculated horse power, the effective fall being 18 feet; required, the area of all the openings in an outward discharging turbine water wheel, to drive the blast, &c., to a furnace which makes 6 tons of No. 1 Iron per day, which requires 42 horse power—find 18 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 25.2 horse power; then, if 25.2 horse power require 100 inches area, 42 horse power will by simple proportion require 166 inches area.—*Answer.*

No. 46.

Required, the width of the canal to convey the water from the dam to the wheel in No. 45 Problem, the depth of the canal being 4 feet—find 18 (the effective fall in No. 45

Problem,) in the column marked "Diameter," (in Table No. 9, Water Power,) opposite to this number in the table, find 42, (horse power of the wheel in No. 45 Problem,) over this number in the column marked "Length," will be found 12 feet, the length of an overshot wheel on the same fall of 42 horse power—find 12 in the column marked "Length," (in Table No. 4, Water Power,) opposite to this number in the column marked "Area," will be found 20, which divided by 4 gives 5 feet, the width of the canal.—*Answer.*

No. 47.

Required, the area of all the openings in an inward discharging turbine water wheel to drive a furnace blast, &c., which makes 3 tons of No. 1 Iron per day, which requires 21 calculated horse power, the effective fall being 12 feet—find 12 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 7.8 horse power; then, if 7.8 horse power require 100 inches area, 21 horse power will by simple proportion require 269 inches area.—*Answer.*

No. 48.

The actual power required in No. 47 Problem is about 16 horse power; required, the width of the belt to transmit 16 horse power, the diameter of the smallest drum being 4 feet—find 16 in the column marked "Horse Power," (in Table No. 2, Belting,) opposite to this number in the table, and under 4 in the column marked "Diameter," will be found 14.4, say 14 inches, the width of the belt.—*Answer.*

No. 49.

The average depth of the water on a dam which is 40 feet long during the summer months is 3 inches; required, the number of cubic feet of water passing over the dam per

second—find 3 in the column marked "Depth," (in Table No. 2, Water Power,) opposite to this number in the column marked "No. Feet," will be found .42, which multiplied by 40 gives 16.8, say 17 cubic feet per second.—*Answer.*

No. 50.

Required the horse power of 17 cubic feet of water per second, the effective fall being 18 feet—find 17 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 18 in the column marked "Diameter," will be found 23.18 horse power.—*Answer.*

No. 51.

Required, the length of an overshot wheel 18 feet in diameter, to transmit 23.18 horse power—find 18 in the column marked "Diameter," (in Table No. 9, Water Power,) opposite to this number in the table find 23.18, or the nearest number to it which is 24.6, over this number in the column marked "Length," will be found 7 feet, the length of the wheel.—*Answer.*

No. 52.

Required, the number of tons of No. 1 Iron that a furnace will make per day, being supplied with the power of an overshot wheel 18 feet in diameter and 7 feet in length—find 18 in the column marked "Fall," (in Table No. 1, Furnace,) opposite to this number in the table find 7, or the nearest number which is 6 or 8, over 6 in the column marked "No. Tons," will be found 3 tons, over 8 will be found 4 tons, hence $3\frac{1}{2}$ tons is due to 7 feet: there is about 25 per cent surplus power in this wheel, hence the actual production is about $4\frac{3}{4}$ tons per day.—*Answer.*

No. 53.

Required, the number of horse power to drive 2 large size circular saws, and two of Woodworth's large size board-planing machines—find 2 in the column marked "Large Size Circular Saws," (in Table No. 1, Miscellaneous Machinery,) opposite to this number in the column marked "Horse Power," will be found 10 horse power:—find 2 in the column marked "Woodworth's Planing Machines," (in Table No. 3, Miscellaneous Machinery,) opposite to this number in the column marked "Horse Power," will be found 12 horse power, which added to 10, makes 22 horse power.—*Answer.*

No. 54.

The effective fall being 12 feet, required, the area of all the openings in an inward discharging turbine wheel to drive 2 large size circular saws, and 2 large size planing machines, which require 22 horse power—find 12 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 7.8; then, if 7.8 horse power require 100 inches area, 22 horse power will by simple proportion, require 282 inches area.—*Answer.*

No. 55.

Required, the number of horse power to drive 2 large size upright saws, (for sawing logs,) and 1 large size circular saw, and 1 large size planing machine—find 2 in the column marked "Upright Saws," (in Table No. 2, Miscellaneous Machinery,) opposite to this number in the column marked "Horse Power," will be found 14 horse power: find 1 in the column marked "Circular Saws," opposite to this number in the column marked "Horse Power," will be found 5 horse power: find 1 in the column marked "Planing Machines," opposite to this number in the column marked "Horse

Power," will be found 6 horse power; then 14, 5 and 6 added together, makes 25 horse power.—*Answer.*

No. 56.

Required, the length of an overshot wheel, the diameter being 12 feet, to produce 25 horse power—find 12 in the column marked "Diameter," (in Table No. 9, Water Power,) opposite to this number in the table find 25, or the nearest number to it, which is 25.8, over this number in the column marked "Length," will be found 11 feet, the length of the wheel.—*Answer.*

No. 57.

Required, the area of the canal to convey the water from the reservoir to the wheel in No. 56 Problem—find 11 in the column marked "Length," (in Table No. 4, Water Power,) opposite to this number in the column marked "Area," will be found 19 feet area; if the canal is 3 feet deep it will be nearly 6 feet wide, because 6 multiplied by 3 gives 19 nearly, or it is $6\frac{1}{3}$ by 3 feet.—*Answer.*

No. 58.

Required, the number of cubic feet of water discharged from the wheel in 56 Problem per second, the wheel is 25 horse power and 12 feet in diameter—find 12 in the column marked "Diameter," (in Table No. 3, Water Power,) under this number in the table find 25, or the nearest number to it, which is 25.45; opposite to this number in the column marked "No. Feet," will be found 28 feet.—*Answer.*

No. 59.

Required, the depth of the water in the wheel pit in No. 56 Problem, the width of the race being 8 feet—find 28 in

the column marked "No. Feet," (in Table No. 5, Water Power,) opposite to this number in the table, and under 8 in the column marked "Width," will be found 12 inches, the depth of the water in the wheel pit.—*Answer.*

No. 60.

Required, the area of all the openings in an outward discharging turbine water wheel, to drive the machinery in 55 Problem, the power to drive which is 25 horse, the effective head being 20 feet—find 20 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 29.5 horse power; then, if 29.5 horse power require 100 inches area, 25 horse power will by simple proportion require 84 inches area nearly.—*Answer.*

No. 61.

Required, the area of all the openings (to drive one large size upright saw, which requires 7 horse power) in the outward discharging turbine water wheel, the head being 5 feet —find 5 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 3.8 horse power; then, if 3.8 require 100 inches area, 7 will by simple proportion require 189 inches area.—*Answer.*

No. 62.

Required, the number of revolutions per minute of the wheel in No. 61 Problem, the diameter being 48 inches—find 5 in the column marked "Head," (in Table No. 13, Water Power,) opposite to this number in the table, and under 48 in the column marked "Diameter," will be found 61 revolutions.—*Answer.*

No. 63.

The effective fall being 12 feet, required, the length of a breast wheel to drive 18 different size cut-nail machines, with the attendant machinery—find 12 in the column marked "Fall," (in Table No. 1, Nail Machines,) opposite to this number in the table, and under 18 in the column marked "No. Machines," will be found 14½ feet, the length of the wheel.—*Answer.*

No. 64.

Required, the area of all the openings in an inward discharging turbine water wheel, the effective head being 16 feet, to drive 16 nail machines of different size, with the attendant machinery; the calculated power is 2 horse power to each machine; then the horse power required to drive 16 machines is 32—find 16 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 12.1 horse power, then if 12.1 horse power require 100 inches area, 32 will by simple proportion require 264 inches area. —*Answer.*

No. 65.

Required, the area of all the openings in an outward discharging turbine water wheel, the head being 6 feet, to drive 8 different size cut-nail machines, which requires 16 horse power—find 6 in the column marked "Head," (in Table No. 12, Water Power,) opposite to this number in the column marked "Horse Power," will be found 4.6 horse power; then, if 4.6 horse power require 100 inches area, 16 horse power will by simple proportion require 347 inches area.—*Aoswer.*

No. 66.

The smallest drum being 6 feet, required, the width of a belt to transmit 16 horse power—find 16 in the column marked "Horse Power," (in Table No. 2, Belting,) opposite to this number in the table, and under 6 in the column marked "Diameter," will be found 9.6, say 10 inches, the width of the belt to transmit 16 horse power.—*Answer.*

No. 67.

Required, the number of dead spindles on No. 25 yarn, to manufacture 3,000,000 pounds of cotton per day; this will give 900,000,000 pounds of cotton per year, the estimated production of the United States—find 25 in the column marked "No. Yarn," (in Table No. 35, Manufacturing,) opposite to this number in the table, and under 4000 in the column marked "No. Spindles," will be found 704 pounds; then, if 704 pounds require 4000 spindles with looms, 3,000,000 pounds will by simple proportion require 17,045, 454 spindles with looms, on No. 25 yarn.—*Answer.*

No. 25 Yarn is probably near the mean or average number, therefore the number of spindles required for this number would probably be nearly equal to the whole number of spindles now spinning the above amount of cotton.

No. 68.

Required, the number of horse power to drive 17,045,454 frame spindles with looms, on No. 25 yarn—find 10,000 in the column marked "Frame Spindles," (in Table No. 3, Manufacturing,) opposite to this number in the column marked "Actual Power," will be found 127.5 horse power; then, if 10,000 spindles require 127.5 horse power, 17,045,454 spindles will by simple proportion require 217,329 horse power.—*Answer.*

No. 69.

Required, the number of cubic feet of water per second, the effective fall being 16 feet, to drive 17,045,454 frame spindles with looms, on No. 25 yarn—find 50 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 16 in the column marked "Diameter," will be found 60.6 horse power; then, if 60.6 horse power require 50 cubic feet per second, 217,329 horse power will by simple proportion require 179,314 cubic feet per second.—*Answer.*

No. 70.

Required, the length of a dam, over which 179,314 cubic feet of water will pass per second, the depth of the water on the dam being 60 inches, or 5 feet—find 60 in the column marked "Depth," (in Table No. 2, Water Power,) opposite to this number in the column marked "No. Feet," will be found 37.8 cubic feet; then, if 37.8 cubic feet require a dam 1 foot long, 179,314 cubic feet will by simple proportion require a dam 4743 feet long, or about $\frac{7}{8}$ of a mile.—*Answer.*

No. 71.

Required, the amount paid for labor per week, to operate 17,045,454 spindles with looms, on No. 25 yarn—find 10,000 in the column marked "Spindles," (in Table No. 17, Manufacturing,) opposite to this number in the table, and under "No. 25," will be found 1080 dollars; then, if 10,000 spindles require 1080 dollars per week to operate them, 17,045,454 spindles will by simple proportion require 1,840,909 dollars per week, or 92,045,450 dollars per year, nearly.—*Answer.*

No. 72.

Required, the amount paid per week, including all expenses except the cost of cotton, to operate 17,045,454 spindles with looms, on No. 25 yarn—find 10,000 in the column marked "Spindles," (in table No. 17, Manufacturing,) opposite to this number in the table, and under "No. 25," will be found 1460 dollars; then, if 10,000 spindles require 1460 dollars per week, 17,045,454 spindles will by simple proportion require 2,488,636 dollars per week, or 124,431, 814 dollars per year, nearly.—*Answer.*

No. 73.

Required, the number of operatives to operate 17,045,454 spindles with looms, on No. 25 yarn—find 10,000 in the column marked "Spindles," (in Table No. 16, Manufacturing,) opposite to this number in the table, and under "No. 25," will be found 300 operatives; then, if 10,000 spindles require 300 operatives, 17,045,454 spindles will by simple proportion require 511,363 operatives.—*Answer.*

The usual capital employed in manufacturing establishments (including the factory, houses, land, &c.,) is about 25 dollars per spindle, hence the capital employed to operate 17,045,454 spindles with looms, is about 426,136,350 dollars.

No. 74.

Required, the cost per yard for manufacturing $\frac{4}{4}$ sheetings, No. 14 yarn, and 2.9 or nearly 3 yards per pound, when cotton is worth 6 cents per pound—find 14 in the column marked "No. Yarn," (in Table No. 19, Manufacturing,) opposite to this number in the table, and under 6 in the column marked "Price of Cotton," will be found 5.95 cents, the cost per yard.—*Answer.*

No. 75.

Required, the cost per yard for manufacturing $\frac{7}{8}$ shirtings, No. 36 yarn, and 5 yards per pound, when cotton is worth 8 cents per pound—find 36 in the column marked "No. Yarn," opposite to this number in the table, and under 8 in the column marked "Price of Cotton," will be found 6.42 cents per yard.—*Answer.*

No. 76.

Required, the cost per yard for manufacturing $\frac{3}{4}$ printing goods, No. 31 yarn, and 5.8 yards per pound, when cotton is worth 6 cents per pound—find 31 in the column marked "No. Yarn," opposite to this number in the table, and under 6 in the column marked "Price of Cotton," will be found 4.24 cents per yard.—*Answer.*

No. 77.

A factory containing 50 $\frac{4}{4}$ looms, and on No. 14 yarn, will turn off about 9900 yards per week; when cotton is worth 7 cents per pound, and the cash price of the goods is 7 cents per yard, required, the profits per week—the cost per yard for making the goods is 6.45 cents, which taken from 7, gives .55 profit per yard, which multiplied by 9900, gives 54.45 dollars per week, or 2722 dollars per year.—*Answer.*

The factory in No. 77 Problem, will contain about 2000 mule and frame spindles, which multiplied by 25 dollars, the usual cost per spindle, gives 50,000 dollars capital. The per cent interest on the capital is nearly $5\frac{1}{2}$.

No. 78.

A factory containing 100 $\frac{4}{4}$ looms on No. 31 yarn, will turn off about 18,000 yards per week; if cotton is worth 7

cents per pound, and the cash price of the printing goods is 5 cents per yard, required, the profits per week—the cost per yard for making this style is 4.46, which taken from 5, gives .54 profit per yard, which multiplied by 18,000, gives 97.20 dollars per week, or 4,860 dollars per year.—*Answer.*

No. 79.

Required, the capital and per cent interest of the factory in No. 78 Problem, for 100 $\frac{3}{4}$ looms on No. 31 yarn—4,000 mule and frame spindles are usually allowed, which multiplied by 25, gives 100,000 dollars capital; 4,860 divided by 100,000, gives 4 $\frac{86}{100}$ per cent interest.—*Answer.*

No. 80.

A factory containing 64 $\frac{7}{8}$ looms, on No. 33 yarn, will turn off about 10,000 yards per week; if cotton is worth 8 cents per pound, and the cash price of the goods being 7$\frac{1}{2}$ cents, required, the profits per week—the cost per yard for making this style of goods is 6.51, which taken from 7$\frac{1}{2}$, gives 1.19 profit per yard, which multiplied by 10,000, gives 119 dollars per week, or 5950 dollars per year.—*Answer.*

No. 81.

Required, the capital and the per cent interest of the factory in No. 80 Problem, for 64 $\frac{7}{8}$ looms on No. 33 yarn—2,500 mule and frame spindles are usually allowed, which multiplied by 25, gives 62,500 dollars capital; 5,950 divided by 62,500, gives 9$\frac{1}{2}$ per cent nearly.—*Answer.*

No. 82.

Required, the horse power of an engine, the diameter of the cylinder being 18 inches, the effective pressure being 50 pounds per inch, and the velocity of the piston 300 feet per

minute—find 50 in the column marked "Pressure," (in Table No. 6, Steam Power,) under this number in the table, and opposite to 18 in the column marked "Diameter," will be found 38.55, which multiplied by 3.00, gives 115.65 horse power; this being an ordinarily finished high pressure engine, deduct 20 per cent, which gives 92.52 effective horse power. —*Answer.*

No. 83.

Required, the diameter of the cylinder of an ordinarily finished high pressure engine, the effective pressure being 55 pounds per inch, and the velocity of the piston being 250 feet per minute, to drive 2000 mule spindles with looms, on No. 30 yarn; the calculated power required is 28 horse power; (see Notes A, B, and C;) 25 per cent of 28 is 7, which added to 28 gives 35, (which is the theoretical power of the engine;) divide 35 by 2.50, which gives 14, (the theoretical power due to 100 feet velocity of the piston per minute,)—find 55 in the column marked "Pressure," (in Table No. 6, Steam Power,) under this number in the table find 14, or the nearest number to it, which is 13.09 or 15.84, say 15.84, opposite to this number in the column marked "Diameter," will be found 11 inches, the diameter of the cylinder.—*Answer.*

No. 84.

Suppose the calculated power in No. 83 Problem was 36 horse power, required, the diameter of the cylinder; 25 per cent of 36 is 9, which added to 36 gives 45, which divided by 2.50 gives 18—find 55 in the column marked "Pressure," under this number in the table find 18, or the nearest number to it, which is 18.84, opposite to this number in the column marked "Diameter," will be found 12 inches, the diameter of the cylinder.—*Answer.*

No. 85.

Required, the diameter of the cylinder of an ordinarily finished high pressure engine, the effective pressure being 60 pounds per inch, and the velocity of the piston being 225 feet per minute, to drive 6000 mule and frame spindles with looms, on No. 30 yarn; the calculated power required is 90 horse power; 25 per cent of 90 is 22.5, which added to 90 gives 112.5, which divided by 2.25 gives 50—find 60 in the column marked "Pressure," (in Table No. 6, Steam Power,) below this number in the table, find 50, or the nearest number to it, which is 51.54, opposite to this number in the column marked "Diameter," will be found 19 inches, the diameter of the cylinder.—*Answer.*

No. 86.

Suppose the velocity of the piston in No. 85 Problem was 275 feet per minute, required, the diameter of the cylinder; then 1125 divided by 275 gives 40.91—find 60 in the column marked "Pressure," below this number in the table find 40.91, or the nearest number to it, which is 41.26, opposite to this number in the column marked "Diameter," will be found 17 inches, the diameter of the cylinder.—*Answer.*

No. 87.

Required, the effective pressure per inch of an ordinarily finished high pressure engine, the diameter of the cylinder being 10 inches, and the velocity of the piston being 250 feet per minute, to drive 3000 frame spindles with looms on No. 25 yarn; the calculated power required is 51 horse power; 25 per cent of 51 is 12.75, which added to 51, gives 63.75, which divided by 2.50, gives 25.5—find 10 in the column marked "Diameter," (in Table No. 6, Steam Power,) oppo-

site to this number in the table find 25.5, or the nearest number to it, which is 25.46, over this number in the column marked "Pressure," will be found 107 pounds, effective pressure per inch.—*Answer.*

No. 88.

Required, the velocity of the piston per minute of an ordinarily finished high pressure engine, the diameter of the cylinder being 12 inches, and the effective pressure being 60 pounds per inch, to drive 3000 frame spindles with looms on No. 40 yarn; the calculated power required is 48 horse power; 25 per cent of 48 is 12, which added to 48 gives 60—find 12 in the column marked "Diameter," (in Table No. 6, Steam Power,) opposite to this number in the table, and under 60 in the column marked "Pressure," will be found 20.56; now if 20.56 horse power require 100 feet per minute, 60 horse power will by simple proportion require 291 feet, the velocity of the piston per minute.—*Answer.*

No. 89.

Required, the diameter of the cylinder of an ordinarily finished high pressure engine, the effective pressure being 50 pounds per inch, and the velocity of the piston being 250 feet per minute, to drive 24 cut-nail machines; the calculated power required is 48 horse power; 25 per cent of 48 is 12, which added to 48 gives 60, which divided by 2.50 gives 24—find 50 in the column marked "Pressure," (in Table No. 6, Steam Power,) under this number in the table find 24, or the nearest number to it, which is 23.32, opposite to this number in the column marked "Diameter," will be found 14 inches, the diameter of the cylinder.—*Answer.*

No. 90.

Required, the diameter of the cylinder of an accurately finished condensing engine, the effective pressure being 30

pounds per inch, and the velocity of the piston being 300 feet per minute, to drive 12 cut-nail machines; the calculated power required is 24 horse power; 33.33 per cent of 24 is 8, which added to 24 gives 32, which divided by 3.00 gives 10.66—find 30 in the column marked "Pressure," below this number in the table find 10.66, or the nearest number to it, which is 10.28, opposite to this number in the column marked "Diameter," will be found 12 inches, the diameter of the cylinder.—*Answer.*

No. 91.

Required, the effective pressure per inch of an accurately finished high pressure engine, the diameter of the cylinder being 10 inches, and the velocity of the piston being 300 feet per minute, to drive 18 cut-nail machines; the calculated power required is 36 horse power; 17.65 per cent of 36 is 6.35, which added to 36 gives 42.35, which divided by 3.00 gives 14.12—find 10 in the column marked "Diameter," (in Table No. 6, Steam Power,) opposite to this number in the table find 14.12, or the nearest number to it, which is 14.04, above this number in the column marked "Pressure," will be found 59 pounds, effective pressure.—*Answer.*

No. 92.

Required, the diameter of the cylinder of an ordinarily finished condensing engine, the effective pressure being 36 pounds per square inch, and the velocity of the piston being 300 feet per minute, to drive the blast, &c., to a furnace which makes 7 tons of No. 1 Iron per day; the calculated power required is 49 horse power; 42.86 per cent of 49 is 21, which added to 49 gives 70, which divided by 3.00 gives 23.33—find 36 in the column marked "Pressure," below this number in the table find 23.33, or the nearest number to it, which is 24.76, opposite to this number in the column

marked "Diameter," will be found 17 inches, the diameter of the cylinder.—*Answer.*

No. 93.

Required, the number of pounds of coarse anthracite coal per day, to drive 6000 mule spindles with looms, on No. 36 yarn; the actual power required is 58.5 horse power—find 58.5, say 58, in the column marked "Horse Power," (in Table No. 2, Steam Power,) opposite to this number in the column marked "Pounds," will be found 2436 pounds of coal.—*Answer.*

No. 94.

Required, the number of pounds of coarse anthracite coal per day, to drive 2000 mule and frame spindles with looms, on No. 30 yarn; the actual power required is 22.5 horse power, say 22—find 22 in the column marked "Horse Power," opposite to this number in the column marked "Pounds," will be found 924 pounds.—*Answer.*

No. 95.

Required, the number of pounds of coarse anthracite coal per day, to drive two run of $4\frac{1}{2}$ feet stones, grinding corn; the actual power required is 28 horse power—find 28 in the column marked "Horse Power," (in Table No. 2, Steam Power,) opposite to this number in the column marked "Pounds," will be found 1176 pounds.—*Answer.*

No. 96.

Required, the number of pounds of coarse anthracite coal per day, to drive 17,045,454 frame spindles with looms, on No. 25 yarn; the actual power required is 217,329 horse power—find 100 in the column marked "Horse Power," opposite to this number in the column marked "Pounds," will be found 4200 pounds; then, if 100 horse power re-

quire 4200 pounds per day, 217,329 horse power will require by simple proportion 9,127,818 pounds per day, or 1,369,170 tons per year (300 working days).

No. 97.

Required, the number of cords of southern pine wood per day, to drive 2000 frame spindles with looms, on No. 14 yarn; the actual power required is 28.5, say 28 horse power —find 28 in the column marked "Horse Power," (in Table No. 3, Steam Power,) as 28 is between 25 and 30, the number of cords of wood required will be between 3 and $3\frac{1}{2}$, say $3\frac{1}{4}$ cords.—*Answer.*

No. 98.

Required, the number of cords of southern pine wood per day, to drive 1 run of $4\frac{1}{2}$ feet stones grinding corn, and 1 run of $4\frac{1}{2}$ feet stones grinding wheat, with all the attendant machinery; the actual power required is 26 horse power—find 26, or the nearest number to it, which is 25, in the column marked "Horse Power," (in Table No. 3, Steam Power,) opposite to 25 in the column marked "Cords," will be found 3 cords.—*Answer.*

No. 99.

Required, the length of a boiler which is 48 inches in diameter, to drive 1000 frame spindles with looms, on No. 14 yarn; the calculated power required is 19 horse power —find 48 in the column marked "Diameter," (in Table No. 1, Steam Power,) below this number in the table find 19, or the nearest number to it, which is 18.8, opposite to this number in the column marked "Length," will be found 18 feet, the length of the boiler.—*Answer.*

No. 100.

A boiler is 26 feet long, and 36 inches in diameter; required, the number of mule spindles with looms, on No. 30 yarn, this boiler is capable of driving; the calculated power of the boiler is 15 horse power; to drive 1000 mule spindles with looms, on No. 30 yarn, it requires 14 horse power; hence, the boiler is capable of driving 1000 spindles.—*Answer.*

No. 101.

Required, the diameter of a boiler, the length being 30 feet, to drive one run of 4½ feet stones grinding corn; the calculated power required is 16 horse power—find 30 in the column marked "Length," (in Table No. 1, Steam Power,) opposite to this number in the table find 16, or the nearest number to it, which is 17.6, over this number in the column marked "Diameter," will be found 36 inches, the diameter of the boiler.—*Answer.*

No. 102.

There are two boilers, each 40 feet long; required, their diameters to drive three board planing machines, and three circular saws; the calculated power required, is 33 horse power—find 40 in the column marked "Length," (in Table No. 1, Steam Power,) opposite to this number in the table, find half of 33, which is 16.6 nearly, over this number in the column marked "Diameter," will be found 30 inches, the diameter of the boilers.—*Answer.*

No. 103.

Required, the number of cubic feet of water per day (12 hours) to supply an engine to drive two circular saws, and two planing machines; the calculated power required is 22 horse power—find 22 in the column marked "Horse

Power," (in Table No. 4, Steam Power,) opposite to this number in the table, and under 12 in the column marked "Hours," will be found 290.4 cubic feet of water.—*Answer.*

No. 104.

Required, the number of cubic feet of water per day (12 hours) to supply an engine to drive two run of 4½ feet stones grinding corn; the calculated power required is 28 horse power—find 28 in the column marked "Horse Power," (in Table No. 4, Steam Power,) opposite to this number in the table, and under 12 in the column marked "Hours," will be found 369.6 cubic feet of water.—*Answer.*

No. 105.

Required, the number of cubic feet of water per day (12 hours) to supply engines to drive 17,045,454 frame spindles with looms, on No. 25 yarn; the calculated power required is 289,772 horse power—find 100 in the column marked "Horse Power," (in Table No. 4, Steam Power,) opposite to this number in the table, and under 12 in the column marked "Hours," will be found 1320 cubic feet; then, if 100 horse power require 1320 cubic feet, 289,772 horse power will by simple proportion require 3,824,990 cubic feet per day.—*Answer.*

No. 106.

Divide 3,824,990 cubic feet by 43,200, the number of seconds in 12 hours, gives 88.5 cubic feet per second; required, the length of a dam over which 88.5 cubic feet of water will pass per second, the depth of the water on the dam being 6 inches—find 6 in the column marked "Depth," (in Table No. 2, Water Power,) opposite to this number in the column marked "No. of Feet," will be found 1.2; then, if 1.2 cubic feet of water require a dam one foot long, 88.5

cubic feet will by simple proportion require a dam 74 feet long, nearly.—*Answer.*

No. 107.

Required, the diameter of an overshot water wheel, to drive 17,045,454 frame spindles with looms, on No. 25 yarn, the constant supply of water being 88.5 cubic feet per second; the actual power required is 217,329 horse power —find 30 in the column marked "No. Feet," (in Table No. 3, Water Power,) opposite to this number in the table, and under 10 in the column marked "Diameter," will be found 22,65 horse power; then, if 30 cubic feet will give 22.65 horse power, 88.5 will by simple proportion give 64.17 horse power; now, if 64.17 horse power require a wheel 10 feet in diameter, 217,329 horse power will by simple proportion require an overshot wheel 33,866 feet, or 6.4 miles in diameter.—*Answer.*

No. 108.

A belt is running 1500 feet per minute; required, the number of square inches in contact with the drum to transmit 1 horse power—find 1 in the column marked "Horse Power," (in Table No. 2, Belting,) opposite to this number in the table, and under 2 in the column marked "Diameter," will be found 1.8 inches, the width of the belt; the diameter of the drum is 2 feet, and the belt is in contact with nearly half the circumference of the drum, which is about 37 inches, which multiplied by 1.8, (the width of the belt,) gives 66.6, say 66 inches, for each horse power.—*Answer.*

No. 109.

A belt is running 1500 feet per minute; required, the weight which each square inch of the belt is constantly raising; 33,000 pounds raised one foot high per minute is equal to one horse power, 22 pounds raised 1500 feet high

per minute, is also equal to one horse power; hence, 66 square inches in contact with the drum, raises 22 pounds 1500 feet per minute, but if 66 square inches raise 22 pounds, one square inch will raise $\frac{22}{66}$ of a pound, or $\frac{1}{3}$ of a pound.—*Answer.*

No. 110.

The diameter of the smallest drum being 10 feet, and the power to be transmitted being 1 horse power, required, the width of the belt—find 1 in the column marked "Horse Power," opposite to this number in the table, and under 10 in the column marked "Diameter," will be found .36, or about one third of an inch in width: it will be noticed that the strength of the belt is not taken into consideration.——*Answer.*

No. 111.

The distance between New-York city and Albany being 160 miles, and the running time of a steamboat in making a trip being 10 hours, which gives 16 miles per hour; and the diameter of the wheels being 30 feet; required, the number of revolutions of the wheels per minute, (presuming that the water does not yield,)—find 30 in the column marked "Diameter," (in Table No. 1, Paddle Wheels,) below this number in the table, find 16 miles per hour, or the nearest number to it, which is 16.06, opposite to this number in the column marked "Revolutions," will be found 15, the number of revolutions per minute.—*Answer.*

No. 112.

In No. 111 Problem, the whole number of revolutions of the paddle wheels during the trip, was 12,000 (found by the indicator on the engine,) required, the per cent slip of the wheel (or water); divide 12,000 by the number of minutes occupied in making the trip, which is 600, which gives 20

revolutions per minute—find 20 in the column marked "Revolutions," (in Table No. 2, Paddle Wheels,) below this number in the table find 16, (miles speed of the boat in No. 111 Problem,) opposite to this number in the column marked "Per Cent," will be found 18 per cent, the slip of the wheel (or water).—*Answer.*

No. 113.

It is estimated that the United States will manufacture 400,000 bales of cotton this year, (1848,) or about 180,000,000 pounds, which divided by 300, (the number of working days in a year,) gives 600,000 pounds per day; required, the number of dead spindles on No. 20 yarn, to manufacture 600,000 pounds of cotton per day—find 20 in the column marked "No. Yarn," (in Table No. 35, Manufacturing,) opposite to this number in the table, and under 4000 in the column marked "No. Spindles," will be found 896 pounds; then, if 896 pounds require 4000 spindles, 600,000 pounds will by simple proportion require 2,678,571 spindles.—*Answer.*

These goods will average about 4 yards to each pound of cotton, then 180,000,000 pounds of cotton will give 720,000,000 yards. Suppose the population of the United States were 20,000,000; required, the number of yards to each person; divide 720,000,000 by 20,000,000, which gives 36 yards to each person.

No. 114.

Required, the amount of capital to operate 2,678,571 spindles with looms—the usual amount invested per spindle, is 25 dollars, which multiplied by 2,678,571 gives 66,964,275 dollars, the present capital employed in cotton manufacturing in the States.—*Answer.*

No. 115.

Required, the number of operatives to operate 2,678,571 spindles with looms, on No. 20 yarn—find 20 in the column marked "No. Yarn," (in Table No. 16, Manufacturing,) below this number in the table, and opposite to 10,000 in the column marked "Spindles," will be found 315; then, if 10,000 spindles require 315 operatives, 2,678,571 spindles will by simple proportion require 84,375 operatives.—*Answer.*

No. 116.

Required, the amount paid for labor per week, to operate 2,678,571 spindles with looms, on No. 20 yarn—find 10,000 in the column marked "Spindles," (in Table No. 17, Manufacturing,) opposite to this number in the table, and under 20 in the column marked "No. Yarn," will be found 1130 dollars; then, if 10,000 spindles require 1130 dollars per week to operate them, 2,678,571 spindles will by simple proportion require 302,678 dollars per week, or 15,133,900 dollars per year.—*Answer.*

No. 117.

Required, the amount paid per week, including all expenses except the cost of cotton, to operate 2,678,571 spindles with looms, on No. 20 yarn—find 10,000 in the column marked "Spindles," (in Table No. 17, Manufacturing,) opposite to this number in the table, and under 20 in the column marked "No. Yarn," will be found 1530 dollars; then, if 10,000 spindles require 1530 dollars, 2,678,571 spindles will by simple proportion require 409,821 dollars per week, or 20,491,050 per year.—*Answer.*